Emotional responses elicited by wine when pairing with high fat food

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ABSTRACT

This work was aimed at the evaluation of emotional responses elicited by wine before and after food consumption. The tastings were performed by one trained panel and by consumers, segmented by gender, Vinotype, 6-n-propylthiouracil (PROP) sensitivity and Saliva flow rate. Three commercial red wines with different sensory features were used: i) Grand Gold awarded wine from Alentejo (2013); ii) wine from altitude vineyards in Douro (2011), iii) classical European old wine (1999) from Bairrada. Wines were evaluated using a tasting sheet with emotional and conventional tasting descriptors before and after eating a typical Portuguese dish, whose distinctive feature was its high fat content.

Overall, food did not change the global evaluation scores given to the wines but some of their characteristics were scored significantly different through the emotional tasting. The results of both panels demonstrated that the emotional responses were more correlated with the global evaluation of the wines than the classical sensory descriptors. Within the trained individuals, the main correlations with global evaluation were obtained with “Initial Impression”, “Expectation for the mouth” and “Impression in relation to odor”. In particular, the global evaluation for the Bairrada wine, could be predicted by a model including these three variables with a R^2=0.73. With the untrained tasters, the correlation with global evaluation was only significant for the “Impression in relation to odor”.

The average scores given to the three wines by both panels did not diverge, despite their different sensory attributes. Therefore, our work only reflected trends in wine preferences. The untrained panel preferred the Alentejo wine while the trained panel preferred the Douro wine, before the food ingestion. The correlations between the global evaluation and the other sensory descriptors for the Alentejo wine could not explain this preference. We speculate that the untrained panel scored the wines based on what they are used to drink, giving lower scores to the unfamiliar one. The trained panel demonstrated a higher correlation between emotional and sensory descriptors. In fact, the trained panel seemed to understand better the different range of qualities of the wines. After ingesting food, the preference changed only for the trained panel, showing preference to the Bairrada wine. Both panels agreed that the old Bairrada was the most complex and difficult wine to understand.

In conclusion, the emotional tasting sheet was easy to interpret by all segments of consumers, leading to open and fair answers because it appeals to individual personal feelings. This tasting approach appears to be promising in the rapid learning of the different wine styles. In the future, it would be interesting to evaluate the evolution of scores given to unfamiliar wines that would require time to be appreciated using appropriate foods. This way, the classical European wines, that are difficult to understand by consumers, would have a better chance to be correctly appreciated.

Keywords: wine, food pairing, sensory analysis, emotions, wine tasting.

RESUMO

Este trabalho teve como objetivo avaliar as respostas emocionais provocadas pelo vinho antes e depois da ingestão de comida. As provas foram executadas por um painel treinado e por consumidores, ambos segmentados pelo seu género e através de três testes: Vinotype, sensibilidade ao PROP e taxa de fluxo de saliva. Foram usados, para tal, três diferentes vinhos comerciais: i) Vinho do Alentejo premiado por um concurso de vinhos com uma medalha Gran Gold (2013); ii) Vinho do Douro proveniente de vinhas de altitude (2011); iii) Vinho clássico europeu evoluído (1999) da Bairrada. Os vinhos foram avaliados através duma ficha de prova com descritores emocionais e convencionais antes e depois de comerem um prato típico português com alto teor em gordura.

No geral, a comida não alterou as pontuações atribuídas aos vinhos mas algumas das suas características foram classificadas diferentemente, através da prova emocional. Ambos os painéis demonstraram que os atributos emocionais estavam melhor correlacionados com a avaliação global dos vinhos do que os descritores sensoriais clássicos. Para o painel treinado as principais correlações com a avaliação global foram obtidas com os seguintes descritores: “Impressão Inicial”, “Expectativa para a boca” e “Impressão em relação ao odor” que deram origem a um modelo linear para a avaliação global do Vinha Pan com um R^2=0.73. Para o painel não treinado, a única correlação significativa foi com “Impressão em relação ao odor”.

As pontuações médias dadas aos vinhos não foram diferentes, apesar das diferenças sensoriais entre os mesmos. Assim, este trabalho reflete somente tendências na preferência dos vinhos. O painel não treinado preferiu o vinho do Alentejo enquanto o painel treinado preferiu o vinho do Douro, antes da ingestão com comida. As correlações entre a Avaliação Global e os outros descritores sensoriais, para o vinho do Alentejo, não explicam a sua preferência. Especulamos que o painel não treinado avaliem os vinhos com base no que estão habituados a beber, dando pontuações mais baixas aos vinhos pouco familiares. O painel treinado demonstrou correlações mais altas entre os descritores emocionais e sensoriais. De facto, o painel treinado parece entender melhor as diferentes gamas de qualidades dos vinhos. Depois da prova pareada com comida, a preferência manteve-se para o painel não treinado, mas para o painel treinado mudou, mostrando preferência para o vinho da Bairrada. Ambos os painéis concordaram que o vinho velho da Bairrada era o mais complexo e difícil de perceber.

Em conclusão, a ficha de prova emocional foi de fácil interpretação para todos os segmentos de consumidores, levando a respostas abertas e honestas pois esta apela aos sentimentos pessoais dos provadores. Esta abordagem à prova de vinhos demonstra ser promissora na aprendizagem de diferentes estilos de vinhos. No futuro, seria interessante avaliar a evolução das pontuações dadas a vinhos estranhos (não familiares) ao provador, que requerem tempo para ser apreciados, usando comida apropriada. Desta forma, os vinhos clássicos europeus que são incompreendidos pelos consumidores teriam uma maior probabilidade de ser corretamente apreciados.

Palavras-chave: comida e vinho, análise sensorial, emoções, prova de vinhos

RESUMO ALARGADO

O presente trabalho pretende avaliar se as respostas emocionais, na avaliação de um vinho, são ou não alteradas quando o mesmo é provado com e sem acompanhamento.

Para tal, foram reunidos dois painéis diferentes: i) o primeiro painel, submetido a provas de treino, partiu de 41 indivíduos a frequentar o mestrado de Viticultura e Enologia, da classe de 2015/2016 no Instituto Superior de Agronomia. O treino consistiu em várias provas pareadas e triangulares onde foram treinados os gostos elementares e algumas sensações gustativas (ácido, doce, amargo e salgado, bem como a adstringência, corpo e calor). No fim das sessões de treino, 20 provadores foram selecionados e estes constituíram o painel treinado; ii) 29 indivíduos escolhidos aleatoriamente, sem treino. Ambos os painéis foram submetidos a uma caracterização fenotípica, que compreendeu um conjunto de 2 testes fenotípicos: teste de sensibilidade ao amargo (utilizando PROP) e uma recolha de saliva (através da ingestão de ácido cítrico). Estes dois testes, bem como um teste online Vinotype e o género dos provadores, serviram como parâmetros de segregação dos mesmos. Os indivíduos foram divididos entre Non-Tasters, Tasters e Super-Tasters, para o teste do PROP; como altos, médios e baixos salivadores, para o teste da saliva; e como Sweet, Hypersensitive, Sensitive e Tolerant para o teste do Vinotype.

De seguida, os provadores foram direcionados para a prova de vinhos, primeiramente sem comida. Foi-lhes apresentada uma prova cega, com três vinhos diferentes: Aragonez 2013, de Cortes de Cima (Regional Alentejo); D. Graça 2011, da Vinilourenço (DOC Douro); e Vinha Pan 1990, de Luís Pato (Regional Beiras). Para a avaliação dos vinhos foram distribuídas fichas de prova emocionais adaptadas de trabalhos anteriores. Os vinhos foram avaliados, dentro de cada parâmetro, com base no gosto pessoal do provador e nada mais. Uma prova idêntica foi feita, desta vez com comida. Escolheu-se utilizar para a prova um guisado de farinheira, um prato pesado, condimentado e com alto teor em gordura, para que o palato do provador fosse atingido fortemente e que sustivesse o vinho mais pesado.

No geral, a comida não alterou as pontuações atribuídas aos vinhos mas algumas das suas características foram classificadas diferentemente, através da prova emocional. Ambos os painéis demonstraram que os atributos emocionais estavam melhor correlacionados com a avaliação global dos vinhos do que os descritores sensoriais clássicos, para ambos os painéis, treinados e não treinados.

O painel não treinado preferiu o vinho Aragonez, enquanto ambos os painéis reconhecessem o Vinha Pan como o vinho mais complexo e difícil de compreender. As correlações entre a avaliação global e os outros parâmetros de prova para o Aragonez não explicaram esta preferência. Especulamos que o painel não treinado pontue os vinhos com base naquilo que os provadores estão habituados a beber, sendo assim mais sensíveis e incapazes de apreciar produtos fora da sua zona de conforto. O painel treinado demonstrou correlações mais altas entre os descritores emocionais e técnicos. De facto, o painel treinado parecia entender melhor a variedade e diferenças dos vinhos, dando respostas mais

constantes. As principais correlações deste painel com a avaliação global foram: “Impressão Inicial”, “Expectativa para a boca” e “Impressão em relação ao odor” que deram origem a um modelo linear para a avaliação global do Vinha Pan com um R^2=0.73.

Nas análises estatísticas realizadas para a segregação dos painéis, verificou-se uma tendência no género: seja no descritor “Cor”, “Corpo” ou “Temperatura”, as mulheres dão notas significativamente mais altas do que os homens. Ambos os painéis se assemelham também nas suas avaliações ao descritor “Duração da fragância”, na segregação pelo teste ao PROP, ou seja, Supertasters sentem o aroma dos vinhos mais longo do que os indivíduos com o status Taster. Embora o Vinotype dos provadores tenha mostrado diferenças significativas para o descritor “Intensidade”, os resultados mostram comportamentos opostos entre painéis: para o painel treinado, os provadores Tolerantes acham os aromas dos vinhos mais intensos comparativamente aos provadores Sensíveis, enquanto para o painel não treinado, as diferenças “respeitam” o espectro de níveis do Vinotype, isto é, os indivíduos Doces e Sensíveis sentem os aromas mais intensos do que os Tolerantes.

No geral, esta prova revelou algumas diferenças simples entre ambos os painéis e vinhos:

i) Os parâmetros emocionais mostraram correlações mais fortes com a “Avaliação Global”, comparativamente com os parâmetros mais técnicos.

ii) Os indivíduos treinados demonstram melhor compreensão dos descritores da prova, dando correlações mais altas, quando comparadas com as correlações do painel não treinado.

iii) O vinho D.Graça apresenta a cor mais agradável para ambos os painéis (maior média amostral), seguido do Aragonez Cortes de Cima e, por fim, o Vinha Pan.

iv) O Vinha Pan destaca-se significativamente dos outros dois vinhos como o mais complexo de aroma.

v) Os Supertaster acham os aromas dos vinhos mais duradouros do que os Taster, para os testes de segregação do PROP de ambos os painéis, no descritor “Duração da fragrância do vinho).

Em conclusão, a ficha de prova emocional foi de fácil interpretação para todos os segmentos de consumidores, levando a respostas abertas e honestas pois esta apela aos sentimentos pessoais dos provadores. Esta abordagem à prova de vinhos demonstra ser promissora na aprendizagem de diferentes estilos de vinhos. No futuro, seria interessante avaliar a evolução das pontuações dadas a vinhos estranhos (não familiares) ao provador, que requerem tempo para ser apreciados, usando comida apropriada. Desta forma, os vinhos clássicos europeus que são incompreendidos pelos consumidores teriam uma maior probabilidade de ser corretamente apreciados.

Palavras-chave: comida e vinho, análise sensorial, emoções, prova de vinhos.

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Astr – Astringency

Complex - Complexity

DOC – Denomination of Controlled Origin

Durat – Duration of the fragrance in the glass

Evol – Evolution of the wine

Expect – Expectation for the mouth

g/L – Grams per Liter

gLMS – General Labeled magnitude scale

Glob – Global Evaluation

Impress – Impression in relation to odor

Init – Initial Impression

Intens – Intensity

OIV – International Organization of Vine and Wine

Perst – Persistency

PROP – 6-n-propylthiouracil

r – Correlation coefficient

R^2 – Determination coefficient

TP – Trained Panel

UTP – Untrained Panel

Ua – Absorbance units

W1 – Aragonez Cortes de Cima

W2 – D. Graça Reserva

W3 – Vinha Pan

1. Introduction

"Wine is a highly personal experience. You may like something your neighbor hates, just as with food. Your bitter is the next person's sweet."

Catherine Fallis, "Wine: Grape Goddess Guides to Good Living" (2004)

1.1 Wine evaluation

1.1.1 Conventional methods

Classical methods for wine tastings have been developed and described since the works of Peynaud (1980) in France and of Amerine (1983) in USA. These methods are based on giving scores to wine sensory characteristics by filling tasting sheets. These sheets are used to train professionals not only in the academic and teaching parameters but are also seen as references by specialists and, despite its present diversity, there are only two major categories of wine tasting sheets: synthetic and analytic (Jackson, 2009). The former may be assessed holistically and/or hedonically, but they intend to evaluate qualitatively wines' characteristics, such as balance, complexity, specific varietal attributes or development. The latter tend to evaluate quantitatively the major sensory attributes (color, aroma and taste). Through these sheets wines are classified with numeric scales with scores ranging from 0 to 5, 0 to 20 or 0 to 100.

The International Organization of Vine and Wine (OIV) has proposed a tasting sheet that is widely adopted (Figure 1.1) among well trained wine professionals with deep wine knowledge.

SCORE SHEET	STILL WINES

Jury	N°	Sample	N°	Category	N°

		Excellent +				Inadequate -	Observations
Visual	Limpidity	☐ (5)	☐ (4)	☐ (3)	☐ (2)	☐ (1)	
	Aspect other than limpidity	☐ (10)	☐ (8)	☐ (6)	☐ (4)	☐ (2)	
Nose	Genuineness	☐ (6)	☐ (5)	☐ (4)	☐ (3)	☐ (2)	
	Positive intensity	☐ (8)	☐ (7)	☐ (6)	☐ (4)	☐ (2)	
	Quality	☐ (16)	☐ (14)	☐ (12)	☐ (10)	☐ (8)	
Taste	Genuineness	☐ (6)	☐ (5)	☐ (4)	☐ (3)	☐ (2)	
	Positive intensity	☐ (8)	☐ (7)	☐ (6)	☐ (4)	☐ (2)	
	Harmonious persistence	☐ (8)	☐ (7)	☐ (6)	☐ (5)	☐ (4)	
	Quality	☐ (22)	☐ (19)	☐ (16)	☐ (13)	☐ (10)	
Harmony – Overall judgement		☐ (11)	☐ (10)	☐ (9)	☐ (8)	☐ (7)	
Total		+	+	+	+	=	
Eliminated due to major defect							0

Figure 1.1 OIV tasting sheet for still wines (OIV, 2009) [a].

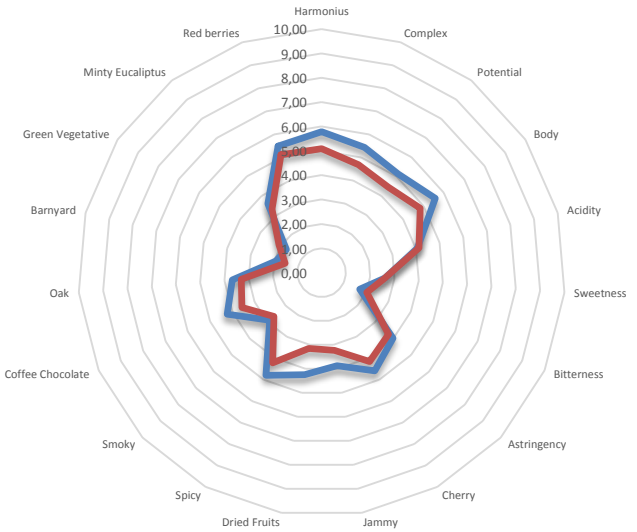
This tasting sheet is required in competitions recognised by the OIV. The jurors "shall be oenologists or persons with an equivalent diploma in the field of wine or spirituous beverages of vitivinicultural origin. Persons having demonstrated a high qualification for tasting in the field of wine and spirituous beverages of vitivinicultural origin may complete the jury" (OIV, 2009) [b]. Those jurors taste the competing wines and evaluate them through tasting sheets like shown in figure 1.1 or similar ones. They will grant the medals and awards based on quality. According to the OIV's *Standard for international wine competitions and spirituous beverages of vitivinicultural origin* (2009), the objectives for the international competitions are: "i) to promote knowledge of wine and spirituous beverages of vitivinicultural of outstanding quality; ii) to encourage their production and responsible consumption as an active part of civilization; iii) to make known and present characteristic types of wine and spirituous beverages of vitivinicultural origin, produced in various countries, to the public; iv) to raise the technical and scientific level of producers and v) to contribute to the expansion of their production."

1.1.2 Characteristics of gold awarded wines

The award of medals is presently a recognized strategy in wine marketing (Nunes et al., 2016). Since the industry needs to fulfill the consumer needs and desires, wines are often displayed in supermarkets with their medals symbolically placed on the bottles. This will create expectations for the regular consumer, opening their curiosity to buy it and, therefore, shaping the market towards the characteristics of the wines that are best awarded. It would be interesting to know which features are preferred by the large tasting panels used in international competitions. As far as we are aware, this perspective has not been worked upon or published yet and so we performed a survey among the internet sites which publish competition results. We found that Mundus-Vini challenge publishes not only the awarded prizes but also the wine sensory profiles (www.mundusvini.com). The number of awarded wines is very high and so we analyzed only those with grand gold and gold medals during the last competitions where sensory profiles were published (2015 to 2016). The published spider graphs for each wine were visually analyzed and average values for the scores were obtained. These average scores are represented in figure 1.2.

1

2



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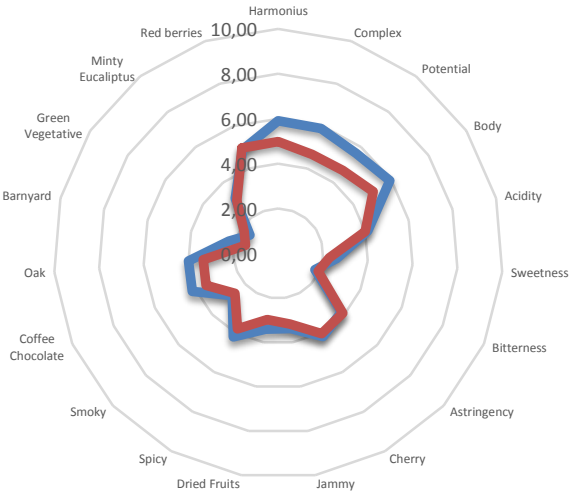

Figure 1.2. Spider graphs of the mean sensory attributes of the Gran Gold and Gold awarded red wines, by Mundus-Vini: 1. 2015 Spring tasting, 2. 2015 Summer tasting and 3. 2016 Spring tasting. (Unpublished observations retrieved from www.mundusvini.com assessed at 15/03/2016).

Although differences may be found among the several editions, the overall sensory profiles are rather similar, suggesting that a certain wine style is systematically preferred by the competition tasters. Our observations are in accordance with Hopfer and Heymann (2014). These authors mention that there is an inclination of wine challenges to attribute the medals/awards to wines with no (or with very low concentrations) of vegetal, animal, chemical and/or earthy profiles. As a consequence, the standard of quality is set for wines with red berries, cherry, dominated by oak, with astringency and body. Consumer's taste becomes shaped in that direction. This is the wine type that most of normal consumers will like, since they have an intense smell but are not so mouthy strong. Descriptors as bitterness or animal, reduction profile or minerality will give us a wine that normal consumers will reject, often saying that the wine is spoiled. Usually only trained individuals and wine experts know how to taste and appreciate these wine characteristics.

In a simple but very systematic manner, Loureiro et al. (2016) named the first wine style as "Easy" and the second as "Difficult". The table 1.1 summarizes the typical comments that an average consumer will give to an "easy" wine versus a "difficult" one when tasting without previous training.

Table 1.1. Typical comments for an average consumer in a wine tasting (adapted from Loureiro *et al.*, 2016).

Parameters	**Easy Wines**		**Difficult Wines**	
	White	**Red**	**White**	**Red**
Visual	Light yellow color	Deep red color	Dark yellow	Light red
Intensity of the smell	Intense, fantastic, appealing		Discrete, smells badly, it stinks!	
Dominant smell	Flowery, fruity, sweetish smells, Happiness to recognize!		Difficult to describe, vegetal, earthy, "harsh". Unhappy for not recognizing.	
Evolution	Stable		Changes favorably	
Expectations for the taste	High expectations		Low expectations	
Feelings after tasting	Disappointing, it disappears!		Surprisingly good, it is tasty!	
Dominant perception	Sweet		Acid, salty, bitter	
Mouth-feel	Smooth, hot, nice!		Irritating, chilly, aggressive and harsh!	
Overall preference	High		Low	
Reassessment	Smells and tastes the same		Improved with time, it's another wine!	
Final conclusions	Simple, short and smooth. Easy to understand.		Complex, persistent and vibrant. Requires learning and time.	

As a consequence, when consumers and experts taste together in wine challenges, a higher score will most likely be assigned to wines with intense fruity-oaky smells and full, smooth mouth-feel, leaving fewer chances for the recognition of classic European wines (Loureiro et al., 2016). For example, classic cool climate wines are typically defined as aggressive and fail to be recognized as of high quality standard by untrained consumers. Having this in mind, Loureiro et al. (2016) described a new tasting approach based on emotional reactions in order to facilitate the understanding of these difficult wines among consumers.

1.2 Wine and emotions

In enology and sensory analysis classes we learn that tasting a wine should be objective. We learn to characterize aromas, like Noble et al. (1984) did when creating the *Wheel of aromas*. We learn how to give a name to the wine colors and to the tasting itself, allowing the wine to be classified through objective parameters. If it is limpid or not, if its odor is intense or if its mouth is long. However, the first thing consumers ask you when you taste a wine is: “Do you like it?”. Though acceptability is normally used to examine liking for food products, more studies now emphasize the importance of determining consumers' conceptualizations, such as their emotions (Schouteten, 2015). Wine is universal. It’s a simple way of getting pleasure, as it is food. Its consumption is not only a physical experience that involves visual appearance, smell and taste, but it is mainly a cognitive and affective experience (Ferrarini, 2010), giving us pleasure and comfort. Wine is a complex product and when consumed, it has to please social, emotional, functional and health aspects in a wine consumer life (Lockshin and Corsi, 2012). We tend to forget that everyone tastes differently, in diversity and intensity, because our brain receptors are genetically different (Mainland et al., 2014). On average, two different persons have over 30% functional differences of their odorant receptor alleles (Mainland et al., 2014). Therefore, wine is difficult to be described by a widely recognized objective set of parameters. Can it be described by a subjective amount of emotions and expectations?

According to Sander et al. (2005), emotion is not a single response but it is series of dynamic events that come over time, as with wine tasting where color is first appreciated, then the aroma and the mouth. Emotional conceptualizations are relations with an emotional implication that reflect what the product is communicating to consumers and how they feel about that product (Thomson et al., 2010). Feelings can be emotions, tempers and attitudes (Meiselman, 2015). Emotions are a specific response to an object or event, and are rapid, intense and last only a short whilst (Meiselman, 2015). So, is it important to take in consideration the emotional/feeling factor, when selling a product?

Barrena and Sanchez (2007) suggested that emotional factors are more important than functional factors in the purchase decision-making process for wine. Pleasure, enjoyment, feel relaxed and mood enhancement are the most relevant emotional associations identified to wine consumption (Barrena and Sanchez, 2007; Charters and Pettigrew, 2008). So, in general, if an individual drinks a wine and he likes it, he will get pleasure from its consumption, therefore he will buy again this same wine, because he knows he will get pleasure from drinking it. With the rapid proliferation of new products into the marketplace, understanding emotional responses may offer a differential advantage beyond traditional hedonic measures (Ng, 2012).

1.3 Wine and food

Food and wine habits are strongly affected by a variety of cultural standards and occasions, like the location's climate, geography, culture, history and traditions (Jackson, 2009). In several European cultures wine is mainly a beverage for food (Jackson, 2009) and Portugal is no exception. Our country has a very deep gastronomic culture and its wines are known for being better appreciated with food, although the guidelines for matching/pairing are subjective and frequently contradictory (WSET, 2011).

Although most people lack ability to match wine and food and despite the diverse personal preferences, there are very few wine choices that will ruin a meal, but good choices can increase the experience of a meal from enjoyable to memorable (Harrington, 2008). The more instinctively way to do a pairing is to choose a wine equivalent to the quality and flavor intensity of the food, the importance of the affair and the participant's mood (Jackson, 2009). Harrington (2008) stated that tannins, oak, alcohol level and body will influence the perception of wine texture as fattiness, protein type, cooking method and body influence the perception of food texture (Figure 1.3).

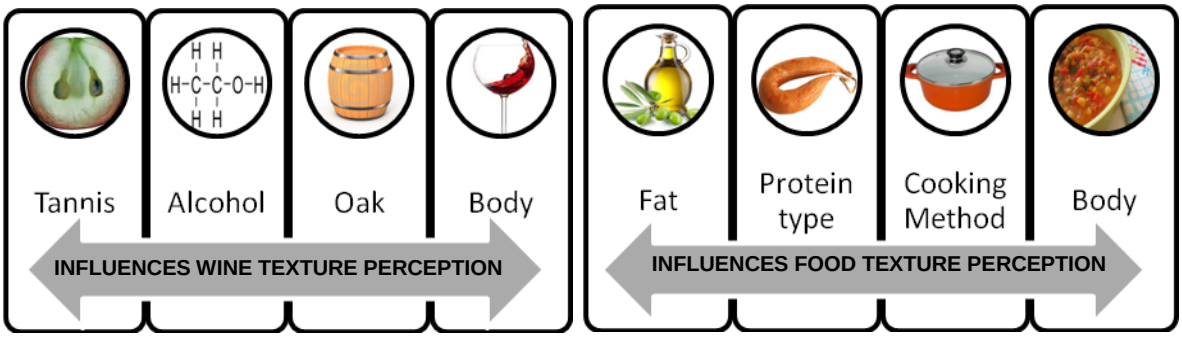

Figure 1.3. Key elements for texture perception in a wine and food pairing.

Generally, a richer, fatter dish will require a richer, more full-bodied wine to complement it (Harrington, 2008), but food and wine pairing can come from different perspectives, rather professional or simply cultural. So, for a good pairing it is necessary to match the wine texture to the food texture. Once those key elements have been properly matched, it can be assumed that the gastronomic sensation will be pleasant. Traditionally, the typical wine pairings are displayed in table 1.2.

Table 1.2. Traditional wine food and pairings (adapted from Puckette, 2015).

Wine Styles	Food pairing
Dry Whites	Vegetables (raw and cooked) and fish
Sweet Whites	Cheeses, carbs[a], smoked meat and desserts
Strong Whites	Cooked vegetables, carbs[a], rich fish and white meat
Sparkling wines	Vegetables (raw and cooked), cheeses, carbs[a] and fish
Light Reds	Cooked vegetables, rich fish and white meat
Medium Reds	Hard cheeses, carbs[a], white meat, red meat and smoked meat
Strong Reds	Hard cheeses, red meat and smoked meat
Dessert Wines	Soft cheese, carbs[a], smoked meat and desserts

[a] Carbohydrates.

These typical matchings also respect the matching of primary flavor interactions, that have effect on wine tasting (increasing or decreasing the same primary flavors in wine), described in table 1.3. In addition, Sosa (2014) understood that pizza together with wine or beer were associated with words like “Friendship, Fun and Sharing”, so emotions do really play an important role in this pairings and should be taken into account in tastings.

Table 1.3. Interaction between primary tastes in food and wine (adapted from WSET, 2011).

Primary tastes (in food)	Increases (in wine)	Decreases (in wine)
Sweetness	Bitterness, Acidity, Astringency, Chemesthesis (burn)	Body, Richness, Sweetness, Fruit
Umami	Bitterness, Acidity, Astringency, Chemesthesis (burn)	Body, Richness, Sweetness, Fruit
Acidity	Richness, Sweetness, Fruit	Acidity
Salt	Bitterness, Acidity, Astringency, Chemesthesis (burn)	Richness Smoothness
Bitterness	Bitterness (although it is highly subjective)	-
Chemesthesis		
Hot, burn, chilli heat, warmness	Bitterness, Acidity, Astringency, Chemesthesis (high correlation with alcohol level)	Body, Richness, Sweetness, Fruit

1.4 Taster segmentation

The sensory properties of wines are a major element that will determine success with consumers. It has been only in recent times that the wine industry and research community have started to apply the principles of sensory evaluation to quantify consumer preferences (Francis, 2015). In particular, attention to consumer segmentation is essential when trying to understand taste sensitivity and preferences. This segmentation can be achieved by common demographic questionnaires (e. g. age, gender, cultural background) or by measurements of the taste functions. In this case, some parameters may be evaluated such as saliva flow rate and sensitivity to 6-n-propylthiouracil (PROP). Recently, a quick online test, called Vinotype, based on overall affective questions, has been devised to anticipate personal wine preferences (Hanni, 2013).

1.4.1 Saliva flow rate

Saliva is the first physical secretion induced by the ingestion of foods or beverages, playing an extensive role in taste perception (Stokes, 2013). Individuals vary strongly in their salivary flow rates and in the degree of salivary response to oral stimuli. Stimulation by oral manipulation or ingestion can affect the salivary flow rate to increase. Not only affects the salivary response, but can also affect perception of taste (Fischer, 1992). Saliva affects taste sensitivity and perception in various ways such as through dissemination of taste substances, chemical interaction with taste substances, stimulation of taste receptors, and protection of taste receptors. These various effects are brought about by the many organic and inorganic constituents of saliva. The concentrations of the salivary constituents in each individual (as well in the same individual under different circumstances) can vary greatly (Matsuo, 2000). The saliva flow rate can be determined with the stimulation of citric acid (Ishikawa and Noble, 1995). According to this test, the taster ingests 10 mL of citric acid (with a 4 g/L concentration) and after 10 seconds collects the expectorated saliva into a cup. In Ishikawa and Noble (1995) research, High salivatory flow rates percept lower intensities of astringency. Heymann et al. (2016) showed, through Time-Intensity curves that Low and Medium Salivary flow tasters perceive astringency in an increasing behavior and High flow salivators do not perceive the astringency probably due to the wash-out effect that their saliva does. Further research used the SPI (Saliva Precipitation Index) as a test that measures the salivary proteins reaction when stimulated by wine polyphenols. Rinaldi (2012) optimized the existing method based on the binding reaction between human saliva and wine and found a significant correlation between SPI and the astringency of red wines (R^2 = 0.969).

1.4.2 Taster phenotype - PROP

Individual differences in gustation have been extensively verified and the most well-known example is the differential response of tasters to phenylthiourea (PTC) and propylthiouracil (PROP) (Fischer, 1992). PROP is member of a class of bitter-tasting compounds classified as thioureas. Thioureas contain the chemical moiety N-C=S, which is responsible for its bitter taste (Bartoshuk et al., 1994). Bartoshuk (1991) reported a trimodal distribution of PROP thresholds, resulting in the classifications of 'Super-tasters', 'Tasters' and 'Non-tasters'.

According to Tepper et al. (2001), the ability to taste this kind of substance~~s~~ is an inherited characteristic shared by approximately 70% of the US adult Caucasian population. The other 30% perceive this substance as weak in intensity or even tasteless, therefore, the participants were segmented according to their evaluation. Those that belong to the 30% are classified as Non-tasters (PROP elicits slight or no bitterness sensation), Tasters for those to whom PROP is considerably bitter, or Super-tasters from those who find PROP extremely intense (Tepper et al., 2001). The ability to taste this compound is more common in women than in men (Whissell-Buechy and Wills 1989), therefore women are supertasters more frequently and have more fungiform papillae and more taste buds (Bartoshuk et al. 1994). Also, this ability is present in young children, declining slowly with age, according to Whissell-Buechy (1990).

The PROP sensitivity test consists in a tasting with 3 glasses with 20 ml each of water solutions with 6-n-propylthiouracil in three different concentrations: 0.032 mM, 0.32 mM and 3.2 mM. Participants rate the bitter sensation of each concentration in a 100 mm general Labeled Magnitude Scale (gLMS) and are classified through the score given to the 0.32 mM solution (Non-taster ≤ 15.5 mm; 15.5 < Taster < 51 mm; Super-taster ≥ 51 mm) (Pickering et al., 2004).

1.4.3 Vinotype

Vinotype is an online wine personalization test. It was launched in 2011, and developed by Tim Hanni, an American Master of Wine, for consumers to learn more about their own preferences (Hanni, 2013). The Vinotype assessment consists in a number of questions that, in the end, determine certain elements each person values about wine/food/sensations and through that, the result is the Vinotype characterization. The participants can be characterized as Sweet, Hypersensitive, Sensitive and Tolerant, according to their responses to the test:

1) Sweet. A Sweet taster is characterized by lining more towards sweet wines or food. This group of people has the higher number of tasting buds. Women (about one in five) are three times more likely to be Sweet Vinotype than men.

2) Hypersensitive. Individuals with “wine preferences towards more delicate, dry wines with lower alcohol levels. Reds have to be especially rich and smooth for your highly sensitive sensory perception”. A little more than a third of both men and women in Hanni’s studies are Hypersensitive. They have intense sensory experiences as the name suggests. Rather than cover up upsetting flavors with sweetness, they instead seek out delicate wines that are dry or off-dry, aromatic and smooth. They avoid big red wines with lots of oak (or any wine with overt oak treatment). Sparkling wines, drier Rieslings and Sauvignon Blanc wines are more adequate for this profile as well as lighter reds like Pinot Noir.

3) Sensitive. Belonging to the largest segment of the sensory sensitivity spectrum these group designation is the center of all the involved parameters. They make up to a quarter of the wine drinking population and Hanni (2013) states that they are the boldest drinkers. They tend to have the widest range of wine preferences and try new things, respecting and enjoying the different styles. They “exhibit the highest degree of phenotypic plasticity, (…) flexible, adaptable, adventurous” and their “wine preferences run a range from delicate to full-bodied, dry white wines to a wide range of reds, especially favoring those that are very rich, smooth but not too oaky or tannic.”

4) Tolerant. This vinotype is less sensitive when it comes to harsh and bitter sensations. People tend to prefer more tannic, powerful, full-bodied red wines and need intensity and high flavor in the white wines. Tolerant people aim for the big reds like Cabernet Sauvignon and are not daunted by high alcohol levels because the smack of the alcohol is mitigated by a deceptive sweetness that they perceive even in a completely dry wine.

1.5 Background and aims of the study

The Portuguese, as an example, are generally considered to be closely linked to wine production and consumption. Portugal is traditionally a wine country, having history and heritage in wine making, and wine will always remain an important product for the Mediterranean diet and Portuguese culture (Panzone and Simões, 2009). Wine production has also a significant importance in the Portuguese economy (Duarte et al., 2010). The high number of gold medals awarded to Portuguese wines in international challenges is a proof that winemakers have achieved standards of worldwide recognition. However, it is a little disappointing that this increase in quality has been done, at least partially, at the expense of the classical characteristics of Portuguese wines. The new wine tasting approach of Loureiro et al. (2016) was developed aiming to increase the understanding of these features by consumers. First results were part of the master thesis of Brasil (2015) and Coste (2016). In these works the initial tasting sheet based on emotional responses was improved, showing that emotional attributes have great potential and are more accessible to consumers to describe and differentiate wines.

This work represents an extension of the previous experience obtained by Brasil (2015) and Coste (2016). These authors included wine tastings in their studies but did not mention the effects of presence of food on the evaluation. Therefore the aims of the study were:

1. To evaluate the influence of food on wine scores obtained through an emotional tasting sheet.
2. To evaluate if the taster responses were influenced by segmentation according to gender, Vinotype, taste sensitivity and tasting experience.
3. To evaluate the main correlations between global appreciation and emotional descriptors.

2. Material and Methods

2.1 Participants

The first tasting panel gathered students from the first year of the enology and viticulture master (class of 2015/2016) and submitted them to some training tastings, with the purpose of a final selection to gather a trained panel test for the final tasting. After this training, they were able to differentiate simple tastes or sensations like acidity, sweetness, sourness, bitterness, astringency and warmness sensation. All the substances used in this training sessions are described in annex 1.

Their characterization as tasters comprehended their age, gender and a few tests to assemble their taster status, like the saliva gathering, the bitterness sensitivity test with PROP and their Vinotype. All the tastings and tests were made using transparent ISO tasting glasses. In addition, we recruited an untrained panel to simulate the typical consumer. This group of participants was subjected to the same characterization tests that the trained panel did, attending only the final tasting.

2.1.1 Training

2.1.1.1 First session - Recognition of simple tastes and sensations

For the first training tasting (February of 2016), 5 different elementary water solutions of tastes and sensations were given to the students, for them to recognize and train (Table 2.1).

Table 2.1. Quantities and purpose of each solution used for the first training session

Taste/Sensation	Reagents	Concentration
Sweet taste	Sucrose	10 g/L
Sour taste	Tartaric Acid	1 g/L
Bitter taste	Quinine Sulphate	0.0108 g/L
Astringency sensation	Aluminium Sulphate	0.8 g/L
Warmness sensation	Ethanol	10% (v/v)

After the first part of this session the tasters had 2 pairs of different sensations aiming to identify the differences between some compounds. The first pair was with two different acids and the other pair compared astringencies. For example: the malic acid is more aggressive and rough in the mouth than the lactic acid. With this, 4 glasses were given to make 2 ISO paired comparison tastings (ISO 5495, 2005). The tasters would then choose which of the acids was

stronger and which of the solutions was more astringent, in the second pair. The sheet for this tasting is presented in annex 2.

Table 2.2. Concentrations of the solutions used for the second part of the first training tasting

Glasses	Purpose	Reagents	Concentration
1st pair	Comparing different acids (sour taste)	Malic Acid	1 g/L
		Lactic Acid	1 g/L
2nd pair	Comparing different astringencies	Aluminium Sulphate	0.8 g/L
		Grape Skin Tannins	0.5 g/L

2.1.1.2 Second session - Combination of simple tastes/sensations

After one week, a second tasting took place. First, 4 glasses were given with the four combinations displayed at table 2.3.

Table 2.3. Combinations of the solutions for the second tasting

Combinations	Reagents
1st combination	Tartaric Acid[a] + Sucrose[b]
2nd combination	Tartaric Acid[a]+ Aluminium Sulphate[c]
3rd combination	Tartaric Acid[a] + Sucrose[b] + Ethanol[d]
4th combination	Tartaric Acid[a] + Sucrose[b] + Ethanol[d] + Skin Tannins[a]

[a] 1 g/l, [b] 10 g/l, [c] 0.8 g/l, [d] 5% (v/v).

With this, the tasters realized the main components of wine - Acidity, Sweetness, Alcohol (Warmness) and Astringency - training to differentiate them alone at first, within the first training session, and gathering one reagent by each combination, reaching the 4th sample and tasting them all together, simulating a wine solution. After this, 4 more glasses were given with the 4th combination plus 3 different finning agents, showed in the table 2.4, with the intention that the tasters could feel different bodies or structures in the solutions, compared to the first glass. The sheet for this session is displayed in annex 3.

Table 2.4. The finning agents and their quantities used to compare the body combined with the 4th combination.

Glass order	Solution [a]	Finning agents	Concentration
1st	4th Combination	-	-
2nd	4th Combination	MannoProteins	0.6 g/L
3rd	4th Combination	Arabic Gum	2 g/L
4th	4th Combination	CMC	0.2 g/L

[a] Description in table 2.3.

2.1.1.3 Third session - Triangular tasting with simples tastes/sensations

The third training session occurred in the beginning of March of 2016 with white and red wine provided by ISA's winery. It was placed an ISO triangular tasting (ISO 4120, 2004) that consisted in 4 different groups with different characteristics (Table 2.5).

Table 2.5. Tasting additions and their concentrations for the triangular tests.

Test	ISA Wine	Addition	Concentration
1st triangle	White	Sucrose	30 g/L
2nd triangle	White	Tartaric Acid	2 g/L
3rd triangle	Red	Quinine Sulphate	0.015 g/L
4th triangle	Red	Tannic Acid	1 g/L

The purpose was for the tasters to differentiate the different glass in each triangle and specify that difference, if they could. The ones who got at least 80% of the answers correct, moved to the next stage in the following week: the same triangular tasting but with different concentrations of the components added, displayed in table 3.6:

Table 2.6 – Additions and their quantities for the second triangular tasting

Test	ISA Wine	Addition	Concentration
1st triangle	White	Sucrose	15 g/L
2nd triangle	White	Tartaric Acid	0.66 g/L
3rd triangle	Red	Quinine Sulphate	0.066 g/L
4th triangle	Red	Tannic Acid	0.5 g/L

For this last session the correspondent sheet can be found in annex 4. With this selection we gathered, for this tasting, 20 individuals out of 41 that showed the most coherent answers.

2.2 Taster segmentation

Our panel was characterized first through a demographic questionnaire about their age, gender, food choices, allergies to food and smoking habits. Besides that, they were asked to answer the online Vinotype test and were also characterized according to their phenotypic characteristics, evaluating them through a PROP bitterness sensitivity test and collecting their saliva. The sheet for this session can be analyzed in annex 5.

2.2.1 Taster phenotype - PROP

This method was the same one used by Pickering et al. (2003). The instructions were for each individual to clean the mouth with a sip of water. Then, the participants were asked to rate the bitterness of three PROP solutions (0.032, 0.32 and 3.2 mM) that were displayed in increasing order of concentration. Each concentration had 20 ml of solution and the participants were instructed to move the sample from side to side in the mouth for 5-10 seconds and then to expectorate. After waiting for 10-15 seconds, they marked in the gLMS scale the intensity of the bitterness sensation of each sample. The participants rinsed thoroughly with water prior to each sample.

2.2.2 Saliva

The tasters were told to take 10 mL of citric acid in their mouth, and keep it in for about 15 seconds. After the 15 seconds they would spit it out and gather, for 1 minute, the saliva produced in a plastic cup, to be weighted after. This method will segregate tasters as High Saliva producers (≥ 3.5 g/min of saliva), Medium (≥ 2.5 and < 3.5 g/min) or Low Saliva producers (< 2.5 g/min of saliva), as described by Ceciliani (2017).

2.2.3 Vinotype

The panel test was asked to access the webpage online (www.myvinotype.com), to do the vinotype test and write down their status on their taster characterization sheet. The test is described in annex 6.

2.3 Emotional Tasting

2.3.1 Wines

The wines used were 3 Portuguese red wines, from 3 different regions, aiming to have a broad range of sensory features. Their main technical characteristics are presented in table 2.7.

Table 2.7. Technical characteristics of the 3 wines used in the tastings

Wine Code	W1	W2	W3
Producer	Cortes de Cima	Vinilourenço	Luís Pato
Brand	Cortes de Cima Aragonez	D. Graça Reserva	Vinha Pan
Grape Varieties	Aragonez	Touriga Nacional, Tinta Roriz, Tinta Barroca	Baga
Vintage	2013	2011	1999
Denomination	Regional Alentejo	DOC Douro	Regional Beiras
Visual	Dark red	Intense red	Low red, brownish
Aromatic Intensity	High	Medium	Low
Oak	Intense	Medium	Medium
Alcohol	14% (v/v)	14% (v/v)	13.5% (v/v)

The first wine is a typical Easy wine. Aragonez Cortes de Cima 2013 was used for this purpose. It is an Alentejo's single varietal (Aragonez) wine with 12 months in french oak (90%) and american oak (10%). In the company's website the following description was available: "Spices and red berry fruits. Soft palate, rich and firm tannins". This wine has been awarded as Grand Gold (Mundus Vini 2016 Spring tasting) and Silver (Concours Mondial Bruxelles 2016).

The second wine was a Douro valley's wine: D.Graça Reserva 2011 from Vinilourenço. This was made with a typical Douro blend, with some mineral and vegetal profile. Not as easy-going as the first one. This one stands as a medium range wine in accordance to the acceptance for the perception of the consumer as a Difficult wine.

The third wine was from Beira Interior "Vinha Pan" produced by Luís Pato from 1999 and it's 100% Baga variety. Seen as an aged and evolved wine, more difficult to understand and with a more complex and strange aroma for the normal consumer. This was considered as the most difficult wine in this study. Probably preferred by wine experts and rejected by the common consumer.

The three wines were analyzed in the ISA Ferreira Lapa laboratory. The analysis' methods are shown in the Tables 2.8 and 2.9.

Table 2.8. Physical and chemical wine Analysis: parameters, methods and expression of the results.

Parameter	Principle	Method	Type[a]	Units
Free and total SO2	Direct iodometric titration	OIV-MA-AS323-04B	IV	Milligrams of Sulphur dioxide per liter of wine
pH	Potentiometry	OIV-MA-AS313-15	I	-
Total Acidity	Titration	OIV-MA-AS313-01	I	Grams of tartaric acid per liter of wine
Volatile Acidity	Titration after distillation	OIV-MA-AS313-02	I	Grams of acetic acid per liter of wine
Fixed Acidity	Difference between total acidity and volatile acidity	OIV-MA-AS313-03	I	Grams of tartaric acid per liter of wine
Alcohol Strength	Ebuliometry	OIV-MA-AS312-01A	I	% Vol.
Dry Extract	Density	OIV-MA-AS2-03B	IV	Grams of dry matter per liter of wine
Reducing Sugars	Defecation	OIV-MA-AS311-01A	IV	Grams of inverted sugar per liter of wine

[a] I, Criterion benchmark method; IV, Auxiliary method.

Table 2.9. Chromatic characteristics of wines: parameters, methods and expression of the results.

Parameter	Principle	Method	Type[a]	Definition	Units
Color Intensity	Spectrometry UV-VIS	Sommers and Evans (1977)	IV	$A_{420}+A_{520}+A_{620}$	Ua
Shade	Spectrometry UV-VIS	Sudraud (1958)	IV	A_{420}/A_{520}	Ua
Total Phenolics	Spectrometry UV-VIS	Ribéreau-Gayon (1970)	IV	A_{280} -4	Ua
Total anthocyanins	Spectrometry UV-VIS	Sommers and Evans (1977)	IV	$[A^{HCl}_{520} - (\frac{5}{3}\times A^{so2}_{520})]\times 20$	mg/L
Ionization index anthocyanins	Spectrometry UV-VIS	Sommers and Evans (1977)	IV	$(A_{520} - A^{SO2}_{520}) / [A^{HCl}_{520} - (\frac{5}{3}\times A^{so2}_{520})] \times 100$	
Pigment polymerization index	Spectrometry UV-VIS	Evans and Sommers (1977)	IV	$A^{SO2}_{520}/A^{HCl}_{520}\times 100$	-
Tannic power	Nephelometry	Freitas and Mateus (2001)	IV	$(d-d_0) / 0,08$	NTU/mL
Chemical age	Spectrometry UV-VIS	Evans and Sommers (1977)	IV	$A^{SO2}_{520} / A^{HCl}_{520}$	-

[a] IV, Auxiliary method

2.3.2 Food recipe

Since the objective of this work was to analyze the emotional responses when pairing wine with food, we chose to pair a fatty dish with some Portuguese ingredients to balance with the three wines. For the food and wine tasting was given to the participants a Portuguese Farinheira stew which ingredients are displayed in table 2.10. This recipe was adapted from Leite M. (2010) book, “Dias com Mafalda”.

Table 2.10. Ingredients and their quantities for the Farinheira stew.

Ingredients	**Quantity**
Olive Oil	1 table spoon
Bacon sliced in cubes	250 g
Farinheira sausage	2 units (460 g)
Red pepper	1 unit (± 200 g)
Garlic Cloves	3 units (± 30 g)
Dry Oregano	1 + ½ tea spoon
Chick Peas (pre-boiled)	400 g
Tomato passata (or in cubes)	600 ml
Chicken stock	1 unit (10 g)

Recipe:

1. Heat up the olive oil into a big frying pan in medium burn. Cook the bacon and the farinheira sausage, turning, for three minutes or till it starts to golden up. Transfer to cooking paper to absorb. Remove the fat excess from the pan leaving just the necessary.
2. Reheat the pan. Add in the red pepper. Cook it for 5 minutes, stirring till it is soft. Reintroduce the bacon and the farinheira sausage, along with the garlic previously minced and the oregano. Stir it for a few more minutes and add the chick peas, the tomato cubes and the chicken stock.
3. Season it with salt and pepper and let it boil. Once it boils, turn down the stove and cook it for more 15 or till the sauce is thick enough. Serve it with bread.

The ingredients and nutritional values for the transformed products (Sliced Bacon, farinheira sausage, chick peas, tomato cubes and chicken stock) are displayed in annex 7.

2.3.3 Emotional tasting protocol

The tasting sheet, discriminated in table 2.11, was based in a previous one described by Coste (2016), taking in consideration the emotional dimension in a wine tasting. In each part of the tasting, a specific emotion is described and evaluated, using a 1 to 5 score in each parameter. It started with the visual evaluation where the taster rates the color of the wine (being 1 for dislike and 5 to like). After, the nose evaluation (olfactory) where, for the first nose impression, the taster evaluates his emotion in a 1 to 5 score: “Distaste (1) to Attraction (5)”. Same goes for the intensity of the aroma, the complexity, and for the last olfactory evaluation, expectation for the mouth. The taste evaluation, involving the mouth, asks the taster to rate the impression in relation to odor, taste perception (thermal, body and astringency) and the final perception (persistency and overall). The third group of the evaluation involves a final olfactory analysis, including the time as a factor: evolution of the wine in the glass (rating 1 for unchanged and 5 to evolving) and the duration of the fragrance (1 to short and 5 to long). In the end the taster gives the wine a final and global evaluation, based in his personal liking being 1: did not like, and 5: liked very much. The tasters had a full descriptor’s explanation (annex 8) attached to their emotional tasting sheet, in case they have doubts about their meaning.

The tasting itself began with the three wines displayed in front of the taster, as well as this emotional tasting sheet. The taster is asked to taste calmly, one wine at a time, and to score the wine for each parameter. Once they’re done, a plastic plate with farinheira stew and bread is distributed, for the second part of the tasting. Now, the taster has to simulate a normal meal and, for that, he is asked to eat 2 or 3 spoons of this stew before beginning to taste the wines again and another’s 2 or 3 spoons during each wine tasting. That way, the components of the food can relate to the wines as in a normal meal.

Table 2.11. Tasting Sheet based on emotions.

Emotional Tasting Sheet			**W1**	**W2**	**W3**
Visual Evaluation					
Color	Dislike (1) to Like (5)				
Olfactory Evaluation					
Initial Impression	Distaste (1) to Attraction (5)				
Intensity	Weak (1) to Strong (5)				
Complexity	Easy (1) to Difficult to describe (5)				
Expectation for the mouth	Low (1) to High (5)				
Taste Evaluation					
Impression in relation to odor	Disappointing (1) to Surprisingly good (5)				
Taste Perception	Thermal	Fresh (1) to Hot (5)			
	Body	Light (1) to Full-bodied (5)			
	Astringency	Smooth (1) to Rough (5)			
Final Perception	Persistency	Short (1) to Long (5)			
	Overall	Unpleasant (1) to Pleasant (5)			
Final Olfactory Evaluation					
Evolution of the wine in the glass		Unchanged (1) to Evolving (5)			
Duration of the fragrance of the wine		Short (1) to Long (5)			
Global Evaluation					
Dislike a lot (1) – Dislike a little (2) – Do not like or dislike (3) – Like a little (4) – Like a lot (5)					

2.4 Statistical Analysis

Assumptions for variance analysis (ANOVA) were assessed and ANOVA was used to analyze the results of the emotional tasting. Tukey HSD (Honestly Significantly Different) test was applied to all pairwise differences between means when significant effects ($p < 0.05$) had been revealed by ANOVA, in order to detect the significant differences between levels. When the difference was not recognized with Tukey's test (probably due to unbalanced samples) Fisher's Least Significant Difference (LSD) was applied. The correlations between the attributes were determined by the Pearson correlation coefficient (r), and the correlation matrices calculated. Statistical analyses were made using the software Statistix 9.0 (© Analytical Software). The boxplot graphics were elaborated with the software OriginLab Microcal (© OriginLab Corporation). Visual interpretations of the correlation matrices were made with software R (© The R Foundation, https://cran.r-project.org/).

3 Results and Discussion

3.1 Wine chemical characterization

The wines used during the tastings were analyzed regarding conventional (Table 3.1) and chromatic (Table 3.2) parameters. The results showed that wines presented usual values for all parameters, being W2 the wine with higher ethanol and dry extract and lower fixed acidity. The values of residual sugar were similar among wines, being unlikely to affect wine sensory mouthfeel. On the contrary, the higher tannic power of W2 should be taken into account when evaluating the astringency responses by the tasters.

Table 3.1. Results from the chemical analysis of the tasted wines.

Wines	Free SO_2 (mg/l)	Total SO_2 (mg/l)	pH	Total acidity[a] (g/L)	Volatile acidity[b] (g/L)	Fixed acidity[a] (g/L)	Alcohol (% v/v)	Dry extract (g/dm3)	Reducing sugars (g/L)
W1	12	80	3.51	5.7	0.58	5.12	13.5	30.7	3.2
W2	11	73	3.69	5.4	0.84	4.56	14.2	35.4	3.1
W3	6	25	3.53	5.5	0.66	4.84	12.9	28.1	2.2

[a] Tartaric acid.; [b] Acetic acid.

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

Table 3.2. Chromatic and polyphenolic analysis results of the tasted wines.

Wines	Color intensity (ua)	Shade (ua)	Total phenolics (ua)	Total anthocyanins (mg/L)	Ionization index anthocyanins (%)	Pigment polymerization Index	Tannic power (NTU/mL)	Chemical age
W1	9.29	0.896	57.48	125	3.82	24.80	450	0.25
W2	14.88	0.816	67.20	85	5.20	40.15	790	0.40
W3	10.79	1.308	53.18	34	4.72	66.66	590	0.47

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

3.2 Participant characterization

The characterization of the participants is shown in tables 3.3 (trained panel) and 3.4 (untrained panel). The main difference in the training was that students from trained panel were in the 2015/2016 class of the Viticulture and Enology ISA Master Degree and went through all of the training sessions, while the untrained panel was composed by random students from the university and outside, simulating the typical consumer, with no previous training. In this

way we tried to have highly motivated individuals whose main difference that could be modulated, were the training in tasting skills.

Table 3.3 Characterization of the trained tasting panel.

Gender	Age	Vinotype	Saliva flow (g/min)	Saliva Status	PROP response (0.32 mM)	PROP status
Female	22	Sensitive	3.4	Medium	27.03	Taster
Female	28	Tolerant	3.6	High	85.17	Supertaster
Female	22	Hypersensitive	2.7	Medium	21.93	Taster
Male	24	Tolerant	2.4	Low	79.56	Supertaster
Female	22	Tolerant	2.2	Low	34.68	Taster
Male	21	Tolerant	2.9	Medium	10.71	Non-taster
Male	23	Sensitive	4.0	High	72.93	Supertaster
Male	22	Sensitive	3.6	High	27.03	Taster
Female	23	Sensitive	2.1	Low	87.72	Supertaster
Male	23	Sensitive	4.4	High	57.12	Supertaster
Male	24	Sensitive	1.4	Low	17.34	Taster
Male	32	Tolerant	2.6	Medium	57.12	Supertaster
Female	25	Sensitive	2.8	Medium	45.9	Taster
Male	24	Sensitive	3.7	High	33.15	Taster
Male	35	Sensitive	3.3	Medium	10.71	Non-taster
Male	23	Sensitive	2.7	Medium	10.2	Non-taster
Male	24	Hypersensitive	3.8	High	42.33	Taster
Male	24	Tolerant	2.8	Medium	29.07	Taster
Female	23	Sensitive	3.5	Medium	77.52	Supertaster
Male	26	Sensitive	6.0	High	31.62	Taster

The demographic and physiological characterization of the two panels is given in Table 3.5. When looking to the two panels in a more organized way, by segmentation, we have a slight disequilibrium in the trained panel gender, since we had more males then females, while in the untrained panel we had almost a 50-50 percent for each gender.

For Vinotype, the trained panel had no Sweet tasters and the majority was Sensitive tasters, followed by Tolerant and Hypersensitive. The untrained Panel, however, had tasters for all the Vinotype profiles but the majority was Hypersensitive, followed by Sensitive, Tolerant and Sweet with only 2 tasters.

Saliva flow showed, again, that the 2 panels were very different from each other. On the trained panel we have the majority as Medium salivators and in the untrained Panel we have the majority as Low salivators.

Table 3.4 Characterization of the untrained tasting panel

Gender	Age	Vinotype	Saliva flow (g/min)	Saliva Status	PROP response (0.32 mM)	PROP Status
Male	24	Sweet	1.1	Low	37.74	Taster
Male	29	Sensitive	3.4	Medium	21.42	Taster
Male	27	Hypersensitive	4.8	High	36.72	Taster
Male	26	Hypersensitive	0.9	Low	9.18	Non-taster
Male	34	Hypersensitive	1.3	Low	36.72	Taster
Female	25	Hypersensitive	1.5	Low	9.18	Non-taster
Female	28	Sensitive	1.5	Low	4.59	Non-taster
Male	28	Sensitive	3.4	Medium	61.2	Super-taster
Male	27	Hypersensitive	2.2	Low	4.08	Non-taster
Male	25	Sensitive	0.9	Low	21.42	Taster
Male	21	Hypersensitive	2.9	Medium	9.18	Non-taster
Female	25	Sweet	3.7	High	21.42	Taster
Female	24	Tolerant	1.8	Low	21.42	Taster
Male	25	Sensitive	3.0	Medium	9.18	Non-taster
Female	24	Hypersensitive	4.2	High	36.72	Taster
Female	31	Tolerant	2.2	Low	17.34	Taster
Male	24	Sensitive	0.9	Low	21.42	Taster
Female	25	Hypersensitive	2.4	Low	37.74	Taster
Female	25	Hypersensitive	2.4	Low	36.72	Taster
Female	25	Sensitive	1.7	Low	21.42	Taster
Male	21	Hypersensitive	3.7	High	9.18	Non-taster
Male	18	Hypersensitive	1.8	Low	21.42	Taster
Male	19	Hypersensitive	1.0	Low	37.74	Taster
Female	24	Hypersensitive	2.5	Medium	3.06	Non-taster
Female	25	Hypersensitive	3.4	Medium	12.24	Taster
Female	22	Hypersensitive	2.8	Medium	38.76	Taster
Female	24	Tolerant	1.5	Low	36.72	Taster
Female	25	Hypersensitive	3.0	Medium	21.42	Taster
Male	23	Sensitive	3.0	Medium	22.44	Taster

For PROP, the distribution between Panels showed that the majority for both panels belong to the Taster status. For the Trained Panel, half of the persons were Tasters, followed by Supertasters and Nontasters. The untrained Panel, having 69% as Tasters, had less Nontasters and only one participant showed a Supertaster status. Tepper et al. (2001) gathered 89 participants and the majority of them were Tasters (57%), followed by Nontasters (25%) and Supertasters (18%). Also according to Tepper et al. (2001), the ability to taste this kind of substances is shared by 70% of the US adult Caucasian population (Tasters and Supertasters) and the other 30% don't perceive it or find it very weak (Non-tasters).

Althought Bartoshuk (1994) and Whissell-Buechy (1989) state that the ability to taste this compound is more common in women than in men, and for that women are supertasters more frequently, the results from both panels do not encourage these conclusions: in the trained panel there's 7 Supertasters and only 3 of them are females and in the untrained panel the only Supertaster is a male.

For Vinotype, although Hanni (2013) stated that the largest segment belong to Sensitive, this is only valid for our trained panel, as seen in table 3.5, with 60% of the trained participants being Sensitive. The untrained panel had only 28% of their participants Sensitive, being that the largest segment was Hypersensitive tasters.

For the saliva test, there was a very different behavior between panels, since the majority of trained participants were medium salivators and of untrained were low salivators.

Table 3.5. Demographic and physiological taster characterization.

	Segment	Trained Panel	Untrained panel
Gender	Female	7 (35%)	15 (52%)
	Male	13 (65%)	14 (48%)
Vinotype	Sweet	0 (0%)	2 (7%)
	Hypersensitive	2 (10%)	16 (55%)
	Sensitive	12 (60%)	8 (28%)
	Tolerant	6 (30%)	3 (10%)
Saliva flow	Low	4 (20%)	16 (55%)
	Medium	9 (45%)	9 (31%)
	High	7 (35%)	4 (14%)
PROP status	Nontasters	3 (15%)	8 (28%)
	Tasters	10 (50%)	20 (69%)
	Supertasters	7 (35%)	1 (3%)
Age	(Mean ± SD)	26 ± 5.5	25 ± 3.2
	(Minimum and Maximum)	(21 - 46)	(19 - 31)

3.3 Overall scores on wine emotional evaluation

The overall scores given to the several parameters of the emotional tasting sheet by both tasting panels are listed in Table 3.6. The mean classifications for the wines before and after food ingestion were very similar, without significant differences.

In particular, Global Evaluation score reported on the emotional tasting sheet for each wine showed no significant differences (Table 3.6). Therefore results can be discussed only as a

tendency. Also, the mean scores and standard deviations for the Global Evaluation, for each wine and panel, are given in table 3.7.

Table 3.6. Evaluation of wines using the emotional tasting sheet.

Parameters	Wines	Trained panel		Untrained panel	
		Before food	After food	Before Food	After food
Color	W1	4.00	3.95	3.79	3.76
	W2	4.20	3.29	3.86	3.90
	W3	3.65	3.76	2.52	2.66
Initial Impression	W1	3.85	3.38	3.55	3.41
	W2	3.15	3.48	2.97	3.21
	W3	3.10	3.67	2.34	2.90
Intensity	W1	3.35	3.43	3.21	3.34
	W2	3.55	3.38	3.38	3.21
	W3	3.50	3.57	3.41	3.31
Complexity	W1	3.05	2.76	2.62	2.79
	W2	2.80	3.00	3.28	3.03
	W3	3.65	3.86	3.52	3.21
Expectation for the mouth	W1	3.45	3.10	3.38	3.10
	W2	3.20	3.14	2.86	3.14
	W3	3.40	3.62	2.45	2.69
Impression in relation to the odor	W1	2.75	3.00	3.28	3.24
	W2	3.20	3.62	2.41	2.83
	W3	3.20	3.33	2.97	3.24
Thermal	W1	3.35	3.19	2.34	2.79
	W2	3.05	3.29	2.66	2.69
	W3	3.10	3.05	2.97	2.90
Body	W1	2.90	2.90	2.31	2.83
	W2	3.10	3.29	2.79	2.97
	W3	3.15	3.24	2.90	2.86
Astringency	W1	3.10	3.05	2.55	2.52
	W2	3.45	3.64	2.90	3.31
	W3	3.25	3.00	2.90	3.17
Persistency	W1	3.25	3.05	3.41	2.97
	W2	3.60	3.29	3.03	3.31
	W3	3.65	3.76	2.97	3.14
Overall	W1	3.30	2.71	3.00	2.90
	W2	2.65	2.86	3.24	3.03
	W3	3.00	2.81	2.83	2.90
Evolution of the wine in the cup	W1	2.50	2.86	2.55	2.52
	W2	2.70	2.65	2.17	2.52
	W3	2.25	2.62	2.62	2.41
Duration of the fragrance of the wine	W1	3.05	3.38	3.52	3.28
	W2	3.10	3.05	3.17	3.07
	W3	3.35	3.33	3.41	3.28
Global Evaluation	W1	3.20	3.43	3.59	3.72
	W2	3.45	3.62	2.83	3.14
	W3	3.40	3.71	2.90	3.14

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

For the trained panel, before food, the preferred wine was W2 (D. Graça Reserva) and the least favorite was W1 (Aragonez Cortes de Cima). For the untrained panel, W1 had the highest scores, followed by W3 and W2, with the lowest. This may be explained by the degree of training. The students of first year of studies were introduced recently to wine tasting and scored better a wine like W1 which was awarded a gold medal in an international wine competition. These wines are of intense aroma with a soft mouthfeel being easily appreciated. The other wines, more astringent (W2) and with light color and reductive smells (W1) need training to be appreciated according to these features.

Interestingly, with the food, the scores increased slightly for all wines for both panels. In the trained panel, the preferred wine changed from W2 to W3 (Vinha Pan) and the least favorite remained W1. For the untrained panel, W1 remained as the most liked wine while the other 2 remained tied.

Table 3.7. Mean scores and standard deviation for wine Global Evaluation before and after food ingestion (TP, trained panel; UTP, untrained panel).

Wine	Panel	Without food	After food
W1	TP	3.20 ± 1.06	3.43 ± 1.32
	UTP	3.59 ± 1.27	3.72 ± 0.84
W2	TP	3.45 ± 0.94	3.62 ± 0.88
	UTP	2.83 ± 1.04	3.14 ± 1.22
W3	TP	3.40 ± 1.14	3.71 ± 1.12
	UTP	2.90 ± 1.35	3.14 ± 1.30

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

In fact, the results showed a high variability which can be better illustrated by the boxplots shown the following figures 3.1 and 3.2 that correspond, respectively, to the "Global Evaluation" scores distribution through boxplots and their respective countings, displayed on the right side of each one. The first figure (2.1) shows that, for the first wine (W1 - Aragonez, Cortes de Cima), the untrained panel (UTP) gathered the highest average value. 25% of the tasters scored W1 with 5, unlike the trained panel (TP), showing a lower average and median, with their scores distributed more evenly between the scores 2 and 4. The second wine, (W2 – D.Graça, Vinilourenço) has a very different distribution between panels: although their median stands in score 3, the untrained panel (UTP) has 50% of the counting below 3, unlike the trained panel (TP) that only 25% stands below 3. For the third wine (W3 – Vinha Pan, Luís Pato) the highest number of countings, for the trained panel (TP) is in 4 score. The untrained panel had a more even distribution of the scores.

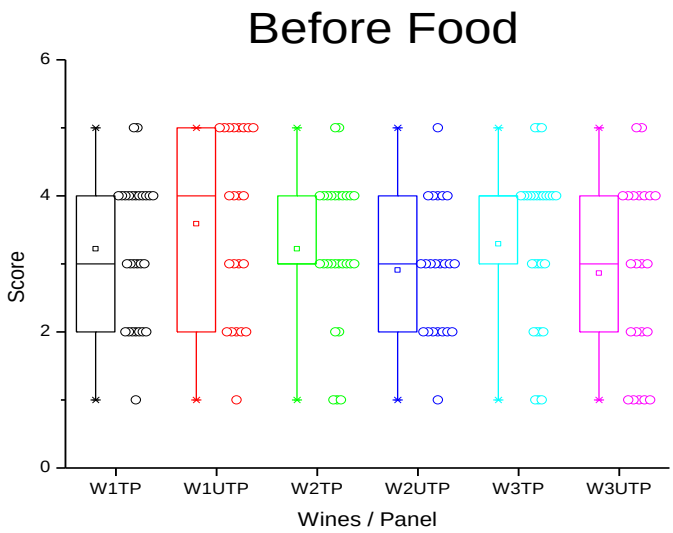

Figure 3.1. Boxplots for the distribution of the ratings given by the tasters (TP – trained; UTP -untrained panels trained and untrained panels) to the Global Evaluation parameter before the ingestion of food. Each graph also shows the average obtained (□) and as the scores (○) correspondent for each taster.

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

The figure 3.2 represents the boxplot's and counting scores for the same parameter, after the ingestion of food. Here we can see that W1 is more appreciated in the untrained panel, once again, 75% of the scores are above 3. The trained panel scored this wine in a wider distribution. W2 presents a similar distribution between panels: 50% of total scores are above 3. W3 is the one that demonstrates the largest differences, since the trained panel scored 50 % higher than 4, unlike the untrained panel that have more below 3.

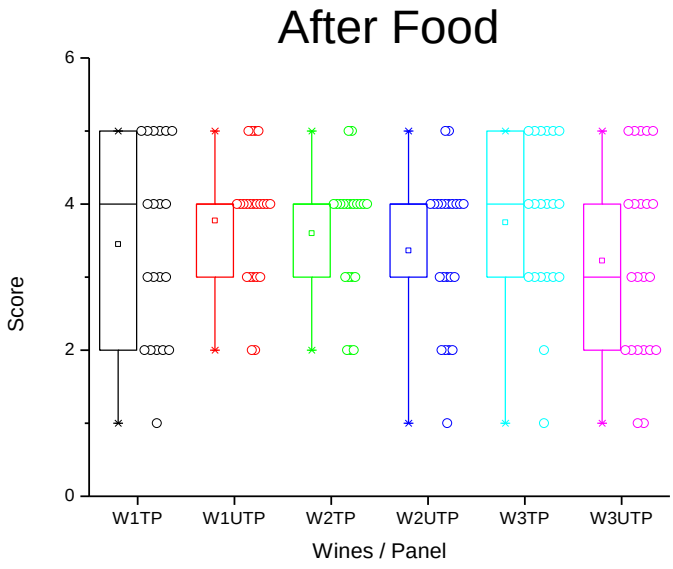

Figure 3.2. Boxplots for the distribution of the ratings given by the tasters (TP – trained; UTP -untrained panels) to the Global Evaluation parameter before the ingestion of food. Each graph also shows the average obtained (□) and as the scores (○) correspondent for each taster.

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

3.4 Correlations among the tasting descriptors

3.4.1 Trained Panel

A Pearson's correlation matrix was obtained using the scores for all evaluated parameters (Table 3.8). Most correlations were very weak. Only 5 correlations were obtained with a correlation coefficient (r) higher than 0.50. Considering the 3 wines together, it can be verified that the attributes most influencing the score given to the "Global Evaluation" were: "Expectation for the mouth", with an r of 0.57, "Impression in relation to the odor" with an r of 0.68 and "Initial Impression" with an r of 0.55 (shown in bold in table 3.8). The parameters less relevant to the "Global Evaluation Score" were "Astringency", "Thermal" and "Intensity" revealing the lowest correlations.

Table 3.8. Pearson´s Correlations for the 3 wines as a set for the Trained Panel.

	Astr	Body	Color	Complex	Durat	Evol	Expect	Glob	Impress	Init	Intens	Overall	Perst
Body	0.39												
Color	-0.17	0.10											
Complex	0.06	0.36	0.26										
Durat	0.07	0.27	0.07	0.07									
Evol	-0.22	-0.00	0.05	0.08	0.18								
Expect	0.02	0.21	0.38	0.55	0.16	0.22							
Glob	0.03	0.27	0.29	0.40	0.34	0.31	**0.57**						
Impress	-0.03	0.42	0.35	0.42	0.33	0.23	0.42	**0.68**					
Init	0.01	0.12	0.38	0.39	0.15	0.18	0.68	**0.55**	0.39				
Intens	0.14	0.05	-0.08	0.14	-0.08	0.03	0.07	-0.03	0.09	0.19			
Overall	0.05	0.19	-0.03	-0.01	0.06	0.09	0.02	0.16	0.11	0.07	-0.05		
Perst	0.32	0.48	0.00	0.43	0.32	-0.09	0.36	0.37	0.43	0.24	0.23	0.04	
Thermal	0.24	0.41	-0.06	0.12	-0.00	-0.17	-0.05	0.00	0.06	-0.03	0.12	-0.02	0.23

Astr – Astringency; Complex – Complexity; Durat – Duration of the fragance of the wine; Evol – Evolution of the wine in the glass; Expect – Expectation for the mouth; Glob – Global evaluation; Impress – Impression in relation to odor; Init – Initial Impression; Intens – Intensity; Perst – Persistency.

Regardless the Global Evaluation correlated descriptors, the other two highest correlations in this panel (underlined in table 3.8) comprise "Initial Impression" and "Expectation for the mouth" with an r of 0.68 (meaning that is highly probable that when you have a good impression in the nose you automatically expect that the wine taste will be good as well) and between "Complexity" and "Expectation for the mouth" with an r= 0.55 (meaning that the more complex the aroma of the wine is, the more the taster expect in taste and vice-versa). This type of behavior is normal and expected for this kind of panel since they are trained and have knowledge in tasting wines, being all part of the viticulture and enology master. These students know what to expect when confronted with a certain aroma or taste and became more tolerant (with a bigger range spectrum of liking), comparing with a normal consumer.

A visual interpretation of this same matrix (figure 3.3) shows that the most correlated descriptors gather in the bottom of the figure, with larger white circles, being them in ascending order: “Evolution of the wine in the glass”, “Color”, “Initial Impression”, “Expectation for the mouth”, “Complexity”, “Global Evaluation” and “Impression in relation to odor”. These should be the most discriminating parameters for this panel. The figure also shows the less important correlations between descriptors (smaller circles as well as the negative correlations, in black circles): “Intensity”, “Thermal”, “Astringency”, “Overall”, “Duration of the fragrance in the cup”, “Body” and “Persistency”. The figure illustrates that more emotional parameters have the highest correlations among them, and for that, are the most important parameters, in this panel, for a wine description based on emotions.

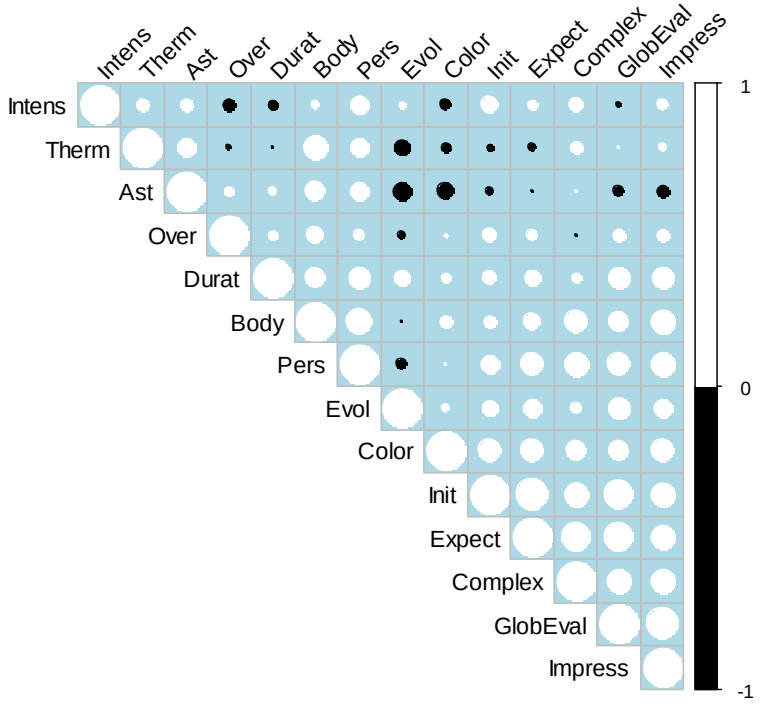

Figure 3.1. Visual interpretation of the correlation matrix, for the three wines, for the trained panel. (White circles = positive correlations; black circles = negative correlations. The higher the circle, the higher the correlation between descriptors).

To detect differences in the emotional response between wines, the same correlation matrix was obtained, individually. The results are shown in table 3.9 and the matrices for each wine in the annexes 9, 10 and 11, for W1, W2 and W3, respectively. For W1, “Impression in relation to odor”, “Initial Impression” and “Expectation for the mouth” were the attributes (in decreasing value) that most contributed for the “Global Evaluation” score. For W2 it was “Impression in relation to odor”, “Persistency” and “Initial impression”. For W3, the 3 strongest correlations had higher values than the correlations described in the other wines. These were: “Expectation

for the mouth" (being the highest correlation), "Impression in relation to odor" and "Initial Impression".

Table 3.9. Strongest correlations between "Global Evaluation" and attributes for each wine, for the trained panel.

Wine	Initial Impression	Expectation for the mouth	Impression in relation to odor	Persistency
W1	0.64	0.45	0.76	< 0.40
W2	< 0.40	< 0.40	0.57	0.53
W3	0.60	0.81	0.68	< 0.40

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

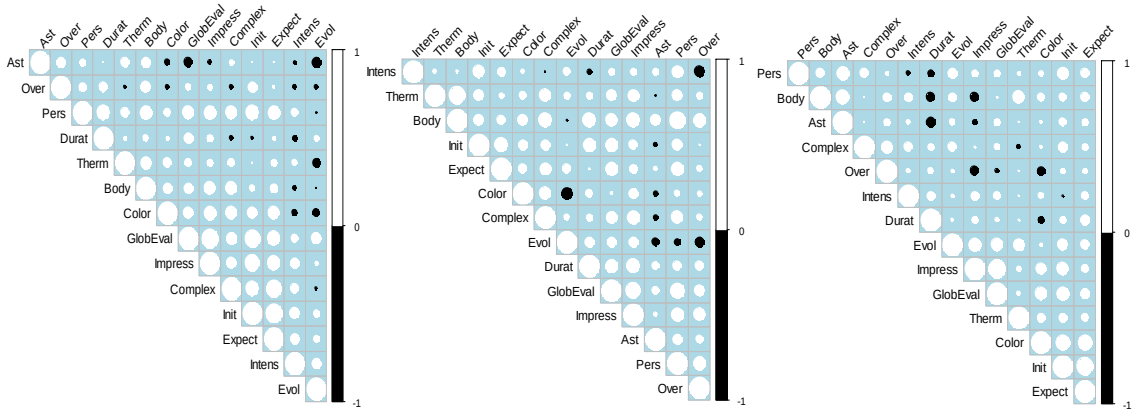

Figure 3.2 – Visual interpretation of the correlation matrix: Aragonez Cortes de Cima – W1 (left), D.Graça Reserva - W2 (center) and Vinha Pan - W3 (right), for the trained panel (White circles = positive correlations; black circles = negative correlations. The higher the circle, the higher the correlation between descriptors).

We tried to relate "Global Evaluation" with these correlations and we came up with a good simple linear regression for W3 wine that showed the highest correlations. With these three parameters: "Expectation for the mouth", "Impress to the odor" and "Initial Impression", the model showed a determination coefficient, $R^2 = 0.73$, that is, 73% of the total variability of the W3's Global Evaluation is explained by this regression:

Global Evaluation = 0.426 + 0.739 * Expectation for the mouth + 0.295 * Impression in relation to the odor – 0.120 * Initial Impression

This regression (discriminated in the annex 12) shows that this wine can be simply explained, in a trained panel, thought descriptors with emotional nature, since their final evaluation of the wine will coincide with the scores given to these descriptors. For the other wines we obtained determination coefficients below 0.4, that we found not interesting for explain this matter (results not shown).

These results are very significant, because they confirm the previous observations of Coste (2015) who, following the same tasting approach, showed that “Initial Impression”, “Expectation for the mouth” and “Impression in relation to odor” were the descriptors with the highest correlations with “Global Evaluation”.
Therefore, a question arises: Can the most complexes wines be better explained by emotional descriptors, when tasted by expertise?

3.4.2 Untrained Panel

In this untrained panel we found even weaker correlations, generally (table 3.10). However, the strongest correlations stand between “Initial Impression” and “Expectation for the mouth” with an r= 0.69 and “Global Evaluation” and “Impression in relation to odor” with an r= 0.61.

Table 3.10. Pearson´s Correlations for the 3 wines as a set for the Untrained Panel

	Ast	Body	Color	Complex	Durat	Evol	Expect	Glob	Impress	Init	Intens	Over	Pers
Body	0.48												
Color	-0.06	0.00											
Complex	0.13	0.10	-0.12										
Durat	-0.05	-0.07	-0.01	0.03									
Evol	0.09	0.18	0.01	0.06	0.08								
Expect	0.08	0.17	0.39	-0.04	0.19	0.18							
Glob	-0.09	0.03	0.27	-0.08	0.33	0.23	0.27						
Impress	-0.13	-0.06	0.14	-0.03	0.13	0.33	0.21	**0.61**					
Init	0.02	0.10	0.45	0.03	0.10	0.19	0.69	0.41	0.32				
Intens	0.12	0.25	-0.01	0.14	0.18	0.10	0.07	0.10	0.03	-0.01			
Overall	0.18	0.15	-0.01	0.09	-0.01	0.06	0.06	-0.04	-0.13	0.08	0.06		
Pers	0.30	0.15	0.00	0.02	0.13	0.01	0.10	0.11	0.10	0.12	0.05	0.07	
Thermal	0.19	0.38	0.04	0.12	0.06	0.14	0.13	0.02	0.12	0.07	0.09	-0.04	0.07

(Astr – Astringency; Complex – Complexity; Durat – Duration of the fragance of the wine; Evol – Evolution of the wine in the glass; Expect – Expectation for the mouth; Glob – Global evaluation; Impress – Impression in relation to odor; Init – Initial Impression; Intens – Intensity; Pers – Persistency).

The visual interpretation of the matrix above, in table 3.10, supports the idea that this untrained panel does not correlate so well their personal liking with any of these parameters, comparing to the trained panel. This type of results lead to the idea that this panel scored the wines based in what they are used to drink, what is familiar to them, being more sensitive and unable to appreciate products outside their comfort zone.

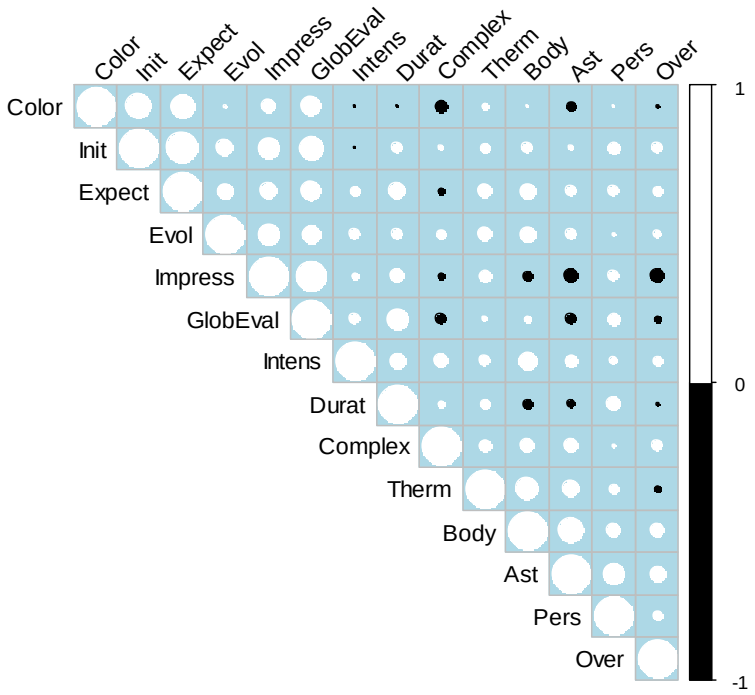

Figure 3.3. Visual interpretation of the correlation matrix, for the three wines, for the untrained panel (White circles = positive correlations; black circles = negative correlations. The higher the circle, the higher the correlation between descriptors).

In the individual matrices, it is, again, the descriptors with emotional nature that stand out in correlations, although in this panel, W1 has the lowest correlations between the three wines (table 3.11). This could be explained by the fact that, the tasters, being themselves normal consumers, are pre-formatted by marketing to like this type of wine, being acquainted. This kind of wine gives the sense of familiar to their brain so, although no parameter can correlate with the preference, this is the most liked wine for this panel. For W2 and W3 there were correlations higher than 0.70 between the “Global Evaluation” and “Impression in relation to odor”. The individual matrices can be found in the annexes 13, 14 and 15 for W1, W2 and W3, respectively. In the visual interpretations (figure 3.4) of the correlation matrices, we can find several black circles (negative correlations).

Table 3.11. Strongest correlations between “Global Evaluation” and attributes for each wine, for the untrained panel.

Wine	Initial Impression	Expectation for the mouth	Impression in relation to odor	Duration of the fragrance of the wine
W1	< 0.40	< 0.40	< 0.40	0.67
W2	0.51	< 0.40	0.76	< 0.40
W3	0.43	< 0.40	0.72	< 0.40

(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

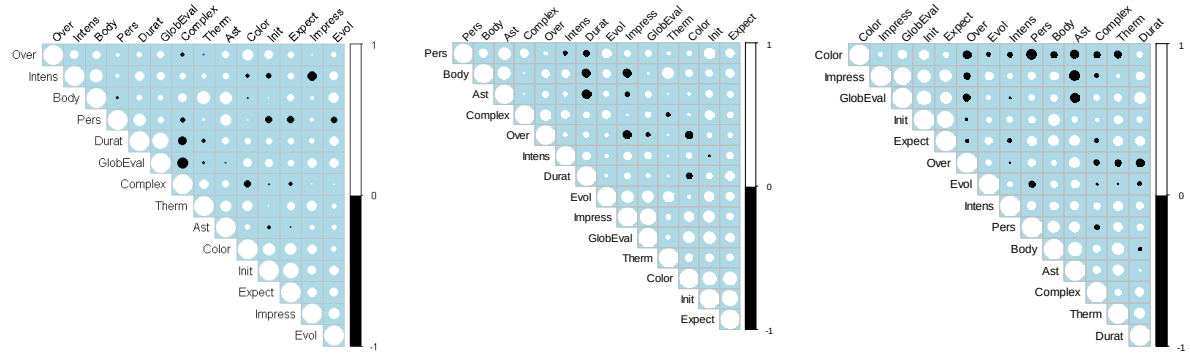

Figure 3.4 . Visual interpretation of the correlation matrix: Aragonez Cortes de Cima - W1 (left), D.Graça Reserva - W2 (center) and Vinha Pan - W3 (right), for the untrained panel (White circles = positive correlations; black circles = negative correlations. The higher the circle, the higher the correlation between descriptors).

In this panel the correlations found were too low to create any regression with a R^2 higher than 0.5 that could predict the “Global Evaluation” score.

3.5 Food and Wine effect

A variance analysis (ANOVA) was made for the food effect in each wine and for the two panels. This test showed no significant differences ($p>0.05$) in the global evaluation of wine, taking them by blocks, when we tested not having or having food (food as a factor), for each panel. Therefore, eating food did not alter, significantly, the evaluated parameters.
In a second step, it was assumed the probability that the wines had a greater influence in the taster’s answers, since they were quite different from each other. The ANOVA, now factorial with interaction, having the wine as one factor (with 3 levels: W1, W2 and W3) and food as another factor (with two levels: without food and with food) provided the results shown below.

3.5.1 Trained Panel

For this first panel, the analysis has shown that, again, food itself did not have influence, as a factor, for the 14 parameters studied (results not shown). However, the wine factor showed significant differences ($p<0.05$) in the pair’s means in the following descriptors: Color, Complexity and Persistence, as is shown in table 4.1.

In “Color”, we can see that the trained tasters gave a higher evaluation to W2, D. Graça wine, differing from W3, Vinha Pan, with the lowest rate in color. This result coincides with the idea that Portuguese, in general, like deep colored red wines, therefore, giving higher scores to the

most dark red wine, according with the chromatic results displayed before (table 3.7), that show W2 as the most color intense, with the highest total phenols and colored anthocyanins.

Table 4.1. Tukey HSD All-Pairwise Comparisons Test of "Color", "Complexity" and "Persistency" for Wine taken as factor in ANOVA.

Descriptor	Wines	Mean
Color	W2	4.25 A
	W1	3.98 AB
	W3	3.70 B
Complexity	W3	3.75 A
	W1	2.93 B
	W2	2.90 B
Persistency	W3	3.75 A
	W2	3.45 AB
	W1	3.03 B

Means followed by the same letter in the column are not significantly different.
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

In "Complexity", W3 is the most complex wine comparing to the other two that resemble in that parameter. W3 is, in aroma, the most difficult to describe, showing aromas of evolution while W2 and W1 have more young aromas, with red fruit and still intense oak. For "Persistency" we had, again, W3 as the one that persists longer and W1 being the less persistent wine.

This analysis showed, as well, significant differences for the interaction between the two factors (Wine and Food) of the "Complexity" mean's (table 4.2).

Table 4.2. Tukey HSD All-Pairwise Comparisons Test of "Complexity" for the interaction Food*Wine

Food	Wine	Mean
Yes	W3	3.85 A
No	W3	3.65 AB
No	W1	3.05 AB
Yes	W2	3.00 AB
No	W2	2.80 B
Yes	W1	2.80 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

With this interaction it was notorious that the real difference was between W3 with food and W2 without food or W1 with food. Although W3 has not changed after food significantly, its complexity increases with it, like W2. The only wine, in this panel, that decreased its rating after the food was W1, supporting the possibility that easy-wines become boring with time and food.

3.5.2 Untrained Panel

The factorial analysis took place with the two factors Wine and Food. As with the trained panel, the major differences were found by the effect of the Wine as a factor. In this analysis, there were significant differences by the wine effect for “Color”, “Initial Impression”, “Complexity”, “Expectation for the mouth”, “Astringency”, “Impression in relation to odor” and “Global Evaluation”, as shown in table 4.3.

Table 4.3. Tukey HSD All-Pairwise Comparisons Test of “Color”, “Initial Impression”, “Complexity”, “Expectation for the mouth”, “Astringency”, “Impress in relation to the odor” and “Global Evaluation” for Wine.

Descriptor	Wines	Mean
Color	W2	3.88 A
	W1	3.78 A
	W3	2.59 B
Initial Impression	W1	3.48 A
	W2	3.09 AB
	W3	2.62 B
Complexity	W3	3.36 A
	W2	3.16 AB
	W1	2.71 B
Expectation for the mouth	W1	3.24 A
	W2	3.00 AB
	W3	2.57 B
Astringency	W2	3.10 A
	W3	3.03 A
	W1	2.53 B
Impression in relation to odor	W1	3.26 A
	W3	3.10 A
	W2	2.62 B
Global Evaluation	W1	3.62 A
	W3	3.02 B
	W2	2.98 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

It is interesting to notice that when the results of global evaluation before and after food were pooled, a significant higher score was obtained for the W1 when compared with W2 and W3. In addition, a trend could be established to explain these preferences by observing the mean scores of the sensory attributes. The preferred wine W1 showed the lower values of complexity and astringency. The W2 was penalized by the higher astringency while W3, in spite of the higher complexity, was penalized by the color and astringency. Therefore, these results are consistent with the style of red wines awarded with Grand Gold medals.

Food showed no significant differences ($p>0.05$) for this panel as a factor alone, although the interaction between Wine and Food had results in “Complexity” (table 4.4) and “Impression in relation to the odor” (table 4.5).

Table 4.4 - Tukey HSD All-Pairwise Comparisons Test of “Complexity” for Food*Wine

Food	Wine	Mean
No	W3	3.52 A
No	W2	3.28 AB
Yes	W3	3.21 AB
Yes	W2	3.03 AB
Yes	W1	2.79 AB
No	W1	2.62 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

Table 4.5 - Tukey HSD All-Pairwise Comparisons Test of “Impress in relation to odor” for the interaction Food*Wine

Food	Wine	Mean
No	W1	3.28 A
Yes	W1	3.24 A
Yes	W3	3.24 A
No	W3	2.97 AB
Yes	W2	2.83 AB
No	W2	2.41 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

3.6 Effect of segmentation

To study the effect of segmentation on wine evaluation, an ANOVA was made with interaction considering Wine as one factor and introducing the segmentation parameters (Gender, PROP, Vinotype and Saliva) as the other factor. The results will comprehend both significant differences between the segmentation levels and also (and once more) between wines. There'll be some results, regarding the wines differences, already detected before in the analysis made for "Wine and Food Effect", starting in page 47. The significant results for each analysis, in each panel, are displayed below.

3.6.1 Trained Panel

3.6.1.1 Gender

For Gender as a factor (with 2 levels: male and female) significant differences were found for the "Color" descriptor for Gender, and of the "Impression in relation to odor" and "Persistency" for Wine and for the interaction Wine*Gender. For Gender our results showed that females gave higher scores to the color of wine, meaning that the wine colors please women more than does to men (table 5.1).

Table 5.1 - Tukey HSD All-Pairwise Comparisons Test of Color for Gender

Gender	Mean
Female	4.21 A
Male	3.85 B

Means followed by the same letter in the column are not significantly different

In "Impression in Relation to odor" and "Persistency" (table 5.2) it is shown, through a LSD test, that W2 and W3 stand together with highest scores, meaning that these two were surprisingly good in taste in relation to their aromas and more persistent than W1, that stands with the lowest mean, differentiating from the two above, since the taste became disappointing in relation to the exuberant aromas that the wine presented, as well as it has a shorter finish.

Table 5.2 - LSD All-Pairwise Comparisons Test of “Impression in relation to odor” and “Persistency” for Wine

Wine	Impression in relation to odor	Persistency
W3	3.3599 A	3.78 A
W2	3.3874 A	3.46 A
W1	2.8214 B	2.93 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

In the results showed by the interaction of Wine and Gender, displayed in the table 5.3, we can see that, although the gender does not influence directly on the scores given to the descriptor “Persistency”, the only different combination is the interaction between Females and W1, with the lowest score contributing in fact for the significant difference in the test above.

Table 5.3 - LSD All-Pairwise Comparisons Test of “Persistency” for Wine*Gender

Wine	Gender	Mean’s
W3	Female	3.86 A
W3	Male	3.69 A
W2	Female	3.50 A
W2	Male	3.42 A
W1	Male	3.23 AB
W1	Female	2.64 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

3.6.1.2 PROP Status

With PROP as the second factor, it was found significant differences in “Color” and in “Duration of the fragrance” descriptors (table 5.4) as well as, for wine, differences in “Complexity” (results showed already before in table 4.1).

Table 5.4 - Tukey HSD All-Pairwise Comparisons Test of
"Color" and "Duration of the fragrance of wine" for Status PROP

Descriptor	Status PROP	Mean
Color	Non-taster	4.35 A
	Super taster	4.06 AB
	Taster	3.77 B
Duration of the fragrance	Super taster	3.50 A
	Non-taster	3.33 AB
	Taster	2.93 B

Means followed by the same letter in the column are not significantly different

No relation between visual evaluations or nose evaluations and PROP was found. Although the analysis has detected significant values, it's not possible to connect this 2 parameters. These results deserve further attention in the future because it is not clear why a taste function may be related to a color evaluation or a smell attribute. It would be interesting to see if the higher score of "Duration of the fragrance" given by Super tasters and Non-tasters could be related with some taste phenotype.

3.6.1.3 Vinotype

When we took Vinotype as the second factor (remaining wine as first factor) we found effects of Wine in "Persistency", "Color" and "Complexity" (these results have already been discriminated in analysis above, in table 4.1).
Vinotype influenced "Global Evaluation" and "Intensity" scores, as seen in table 5.5. Since the trained panel had no Sweet tasters and only 2 Hypersensitive, we aggregated Sweet and Hypersensitive tasters with the Sensitive, for the analysis to run balanced.

Table 5.5 - Tukey HSD All-Pairwise Comparisons Test of
"Global Evaluation" and "Intensity" for Vinotype

Descriptor	Vinotype	Mean
Global Evaluation	Sensitive and Hypersensitive	3.61 A
	Tolerant	3.17 B
Intensity	Tolerant	3.81 A
	Sensitive and Hypersensitive	3.37 B

Means followed by the same letter in the column are not significantly different.

We found as well influence of the interaction between Wine and Vinotype for the "Intensity", showed in table 5.6, where Sensitive tasters (as seen before) rated the "Intensity" of the wines

lower than Tasters and with no significant differences between wines. Tasters, however, showed a different rating for W3, standing out as the most intense wine for this Vinotype profile.

Table 5.6 - LSD All-Pairwise Comparisons Test of
"Intensity" for the interaction between Wine*Vinotype

Wine	Vinotype	Mean
W3	Tolerant	4.25 A
W2	Tolerant	3.75 AB
W1	Tolerant	3.42 AB
W2	Sensitive	3.40 B
W3	Sensitive	3.36 B
W1	Sensitive	3.35 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

3.6.1.4 Saliva

For Saliva segregation another ANOVA was elaborated, maintaining wine as the first factor (three levels), Vinotype as a second factor (two levels) and saliva as a third factor (three levels: Low, Medium and High). We observed differences for the Saliva factor only for "Evolution of the wine in the glass" (table 5.7). These results are perhaps artifacts of the statistical analysis because saliva flow should not be related to the orthonasal evaluation of the "Evolution of the wines in the glass".

Table 5.7 - Tukey HSD All-Pairwise Comparisons Test of
"Evolution of the wine in the glass" for Saliva.

Saliva Flow Rate	Mean
Low	3.08 A
High	2.85 AB
Medium	2.29 B

Means followed by the same letter in the column are not significantly different

3.6.2 Untrained Panel

3.6.2.1 Gender

For this analysis, for the untrained panel, we found significant results ($p<0.05$) for Gender in "Body" and "Thermal" (table 5.8) and for the interaction between Wine and Gender in

“Astringency” (table 5.9) and “Initial Impression” (table 5.10).

In this panel, women rated all the wines as more warm and with more body as seen in table 5.8. In the Trained Panel’s gender segmentation, in the “Color” descriptor, females rated significantly higher than males (table 5.1).

Table 5.8 - Tukey HSD All-Pairwise Comparisons Test of “Body” and “Thermal” for Gender

Descriptor	Gender	Mean
Body	Female	2.94 A
	Male	2.60 B
Thermal	Female	3.01 A
	Male	2.42 B

Means followed by the same letter in the column are not significantly different

For the interaction between Wine and Gender, we can see that the main significant difference was between the second wine (W2) and females, scoring this wine as the most astringent, table 5.9, and the first wine (W1) and males, scoring this wine as the least astringent. All the other variables presented an intermediate behavior.

Table 5.9 - Tukey HSD All-Pairwise Comparisons Test of “Astringency” for the interaction between Wine*Gender

Wine	Gender	Mean
W2	Female	3.23 A
W3	Female	3.10 AB
W2	Male	2.96 AB
W3	Male	2.96 AB
W1	Female	2.70 AB
W1	Male	2.36 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

Again, in the same interaction, “Initial Impression” had significant differences mainly between Female and W1 and W3 in general (females and males), meaning that females, in this Non Trained Panel, feel the most attraction to the Alentejo wine and that W3, Vinha Pan, gave more displeasure to both female and male (table 5.10).

Table 5.10 - Tukey HSD All-Pairwise Comparisons Test of
"Initial Impression" for the interaction between Wine*Gender

Wine	Gender	Mean
W1	Female	3.80 A
W1	Male	3.14 AB
W2	Male	3.11 AB
W2	Female	3.07 AB
W3	Female	2.80 B
W3	Male	2.43 B

Means followed by the same letter in the column are not significantly different
(W1 – Aragonez Cortes de Cima; W2 – D.Graça Reserva; W3 – Vinha Pan)

3.6.2.2 PROP Status

The analysis showed effect of this segmentation as an isolated factor in "Initial Impression", "Evolution of the wine in the glass" and in "Duration of the fragrance of the wine". The interaction between Wine and PROP resulted in a significant difference for the descriptor "Expectation for the mouth". Some of these differences could not be detected through Tukey's all-pairwise comparisons test, probably because the model assumptions were not fully verified (unbalanced samples). In these cases, it was applied the LSD test but it was not possible to discriminate values, since even this test can not recognize the differences when compared pairs. The only parameter where differences were detected through Pairwise comparisons was "Duration of the fragrance of wine", having the means displayed in the table 5.11.

Table 5.11 - Tukey HSD All-Pairwise Comparisons Test of
"Duration of the fragrance of wine" for PROP

PROP Status	Mean
Supertaster	4.50 A
Non-taster	3.83 A
Taster	3.01 B

Means followed by the same letter in the column are not significantly different

3.6.2.3 Vinotype

For this test there were only differences in “Intensity” and for the interaction between Wine and Vinotype of “Body”. Although the ANOVA showed significant differences, Tukey’s test did not detect them when comparing pairs and the LSD test only detected the effect of Vinotype in “Intensity”, showed in table 5.12. This results showed that Sweet and Sensitive tasters find the wines more intense aromatically, rating them higher in this descriptor. Tolerant tasters rate significantly lower, finding all the wines less intense in the aroma, contrarily to the results provided by the trained panel (table 5.5). Although the main differences coincided with the description of Vinotype profiles, Hypersensitive should not have an intermediate behavior, since the spectrum of sensibility is in the order: Sweet, Hypersensitive, Sensitive and Tolerant.

Table 5.12 - LSD All-Pairwise Comparisons Test of “Intensity” for Vinotype

Vinotype	Mean’s
Sweet	3.75 A
Sensitive	3.56 A
Hypersensitive	3.22 AB
Tolerant	2.83 B

Means followed by the same letter in the column are not significantly different

3.6.2.4 Saliva

For this factor there were significant differences of “Initial Impression”, “Complexity” and “Global Evaluation” (table 5.13). The interaction between Saliva and Wine showed differences of “Overall taste evaluation” (not detected by Tukey’s or LSD’s test).

Table 5.13 - Tukey HSD All-Pairwise Comparisons Test of “Initial Impression”, “Complexity” and “Global Evaluation” for Saliva

Descriptor	Saliva Flow Rate	Mean
Initial Impression	High	3.54 A
	Low	3.10 AB
	Medium	2.75 B
Complexity	Low	3.28 A
	High	3.25 A
	Medium	2.54 B
Global Evaluation	High	3.83 A
	Low	3.15 B
	Medium	3.02 B

Means followed by the same letter in the column are not significantly different

3.6.3 General comparison of segmentation effect in both panels

The effect of segmentation on the wine evaluation was quite diverse according to each evaluated parameter or to taste training. Considering both factors (wine and segmentation factor), we only found coincidence of segmentation effect regarding Vinotype for “Intensity”, and PROP for “Duration of the fragrance”. Table 3.6 shows where significant differences were found, for each descriptor in the segmentation analysis, for both panels.

Table 6. Effect of segmentation on the evaluation scores for each tasting parameter.

Parameters	Trained Panel	Untrained Panel
Color	Gender, PROP	-
Initial Impression	-	Saliva, Wine*Gender
Intensity	Wine*Vinotype, Vinotype	Vinotype
Complexity	-	Saliva
Expectation for the mouth	-	-
Impression in relation to the odor	-	-
Thermal	-	Gender
Body	-	Gender
Astringency	-	Wine*Gender
Persistency	Wine*Gender	-
Overall	-	-
Evolution of the wine in the glass	-	-
Duration of the fragrance of the wine	PROP, Saliva	PROP
Global Evaluation	Vinotype	Saliva

When comparing the results for each segmentation parameter, there was a tendency for both panels in Gender. Concerning Color, Body or Thermal, females always evaluated significantly higher than males. Also, when regarding “Duration of the fragrance of the wine” both panels were related for PROP: Supertasters found the wine aromas to last longer than Tasters.

Though having significant differences found in Vinotype for “Intensity”, the results showed two different behavior between panels. If in one side in the trained panel, Tolerant tasters found the wine aromas more intense when comparing to Sensitive tasters, in the other side in the untrained panel it seemed to “respect” more the Vinotype spectrum, since the Tolerant individuals found the aromas less intense while Sensitive and Sweet tasters found the wines considerably more intense aromatically.

4. Conclusions and future perspectives

The overall results demonstrated that the emotional attributes (Initial Impression, Expectation for the mouth, Impression in relation to odor) were more correlated with the global evaluation of the wines than the classical sensory descriptors, for both trained and untrained panel. However, the trained panel demonstrated a higher correlation between emotional and technical descriptors. In fact, the trained panel seemed to understand better the different range of qualities of the wines, giving more constant responses. Some of the presented results may not have a scientific or sensorial explanation, since they can only be statistical coincidences.

The method was applied before and after food and, globally, food did not influence the global evaluation given to the wines. Moreover, we did not find differences in wine preferences given the large variability of scores. As a tendency, the preferred wine before food was D. Graça Reserva for the trained panel and Aragonez Cortes de Cima for the untrained panel. This observation is consistent with the fact that the latter was a Grand Gold awarded wines, known to be especially attractive due to its intense sweetish flavors and smooth mouthfeel. It was particularly interesting to observe that food seemed to increase the liking of all wines and favored the Vinha Pan with the trained panel, which became the most liked wine. The untrained panel maintained its higher preference for the Aragonez wine before and after food. Overall, all wines performed well when challenged by food despite being of different styles. Probably, when pairing with high fat foods red wines play the role of palate cleansers, being individual preferences hidden in the overall group response. Future research is also required to find if these individual responses may be consistently explained by other types of consumer segmentation.

As expected, the untrained panel preferred the easiest wine to taste although both panels established Vinha Pan as the most complex and difficult to understand wine. The correlations between the global evaluation and other tasting parameters for the Aragonez wine could explain this preference, based on its lower astringency and higher initial expectation given by the smell. We speculate that the untrained panel scored the wines based in what they are used to drink being more sensitive and unable to appreciate products outside their comfort zone. This leads to the idea that, for the future, there should be a new parameter to study that refers to wine familiarity, especially when gathering tasters with no or little knowledge or training.

Finally, the emotional tasting sheet was easy to interpret by all segments of consumers, leading to open and fair answers because it appeals to their personal feelings. The emotional

responses were not constrained by the wish to give the “right answer” and so individuals gave their scores more freely without losing the ability to discriminate wines.

This tasting approach appears to be promising in the rapid learning of different wine styles. It would be interesting to evaluate the evolution of scores given to unfamiliar wines that require time to be appreciated using appropriate foods. Hopefully, the classical European wines that are difficult to understand by consumers would have a better chance to be correctly appreciated.

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Annexes

Annex 1 - List of the purchases of the substances used in the tasting sessions

Reagent	Name of the Substance	Purchased from	City / Country
Aluminium Sulphate	Aluminiumsulfate-18-hydrat	Riedel-de Haën	Seelze. Germany
Lactic Acid	DL – Lactic Acid	Sigma	St. Louis. USA
Ethanol	Ethanol 96% (v/v)	Agar	Lisbon. Portugal
Malic Acid	L (-) Malic Acid	Sigma	St. Louis. USA
Tartaric Acid	L (+) – Tartaric Acid	Panreac	Barcelona. Spain
Quinin Sulphate	-	Acofarma	Barcelona. Spain
Skin Tannins	Tanin Vr Grape	Laffort SA	Bordeaux. France
Sucrose	-	Sigma	St. Louis. USA
Soft Gum	E-414	A Freitas Vilar. Lda	Lisboa. Portugal
Carbomethylcelullose (CMC)	Cristab GC	ProEnol	Porto. Portugal
MannoProteins	OENOLEES® MP	Laffort SA	Bordeaux. France
Citric Acid	Citric Acid Monohydrate	Merck	Darmstad. Germany
PROP	6-n-propylthiouracil	Sigma	St.Louis. USA

Annex 2 – First training tasting session sheet

Date:__/__/_____	Student Number:_____
Previous Wine Knowledge:_____	Vinotype:_____

Recognition of simple tastes / sensations. Write after each solution the basic sensation you feel after tasting it.

1-_____

2-_____

3-_____

4-_____

5-_____

6-_____

What is the difference between the solutions?

A-_____

B-_____

What is the difference between the solutions?

C-_____

D-_____

Annex 3 – Second training tasting session sheet

Date:__/__/_____	Student Number:_____
Age:_____	Vinotype:_____

Recognition of simple tastes / sensations. Write after each solution the basic sensation / taste you feel after tasting it.

1- _____+_____

2-_____+_____

3-_____+_____+_____

4-_____+_____+_____+_____

In which solution you think has more body?

A-_____

B-_____

C-_____

Annex 4 – Third training tasting session sheet

Date:__/__/_____ Student Number:_____

Name:_____

There are three samples of wine in which two are the same and one is different. Try the samples from left to right and cross the one that seems different in each set. Drink some water between the samples.

1- ☐ ☐ ☐
2- ☐ ☐ ☐
3- ☐ ☐ ☐
4- ☐ ☐ ☐

If you can please tell why you think the sample you chose its different using the basic sensations that you've been practicing.

1-_____

2-_____

3-_____

4-_____

Annex 5 - Taster Characterization Status sheet

Name: _____ Age:_____ Gender: M ☐ F ☐

Vegetarian: Yes ☐ No ☐ Allergies:_____

Smoker:_____ Date: ____/____/2016

TASTER CHARACTERIZATION

In order for us to evaluate your status as a taster. you need to access to these three tests:

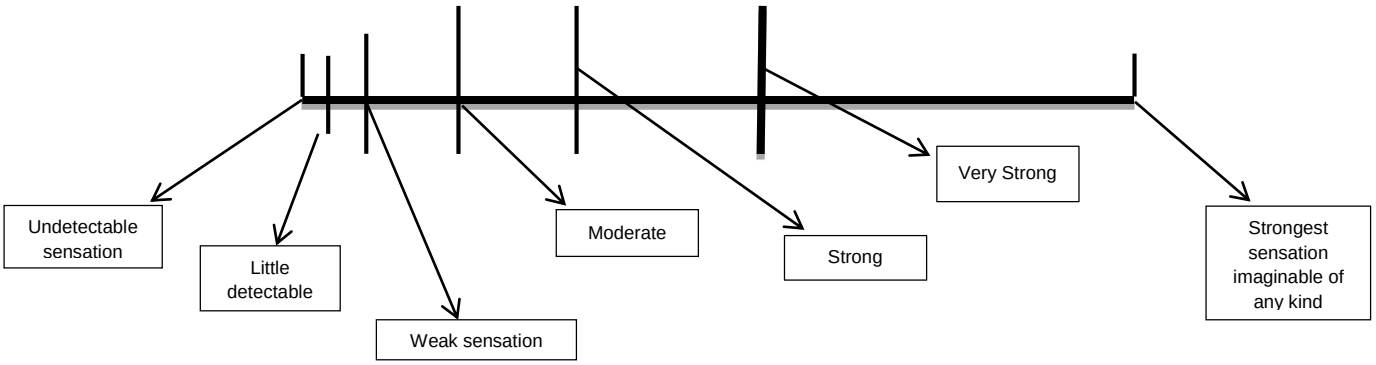
1. Saliva Flow Test

In the glass Number 1 is citric acid. When putting in your mouth. Chew it for 15 seconds and discard. Collect the saliva produced for 1 minute into the plastic cup.

Cup Initial Weight= _____ Weight Cup + Saliva =_____ Saliva Weight=_____

2. PROP Sensibility Test

In the glasses Number 2, 3 and 4 is an aqueous solution with 0.032 mMol/L, 0.32 mMol/L and 3.2 mMol/L of PROP, accordingly.
On the following scale, mark vertically the intensity of the bitter sensation you detect by tasting it:

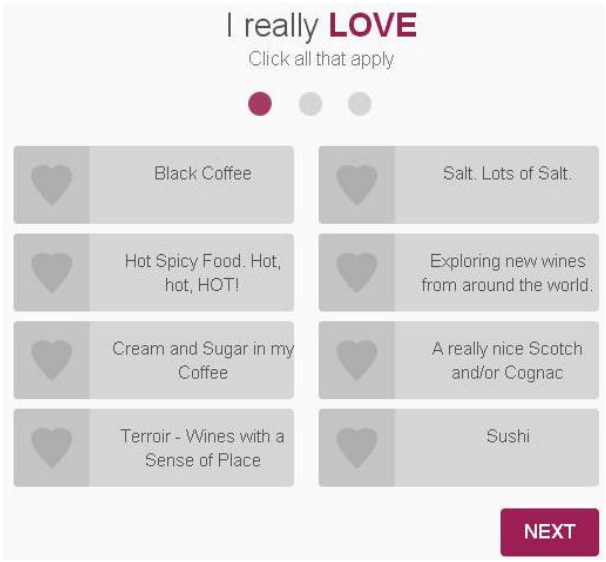


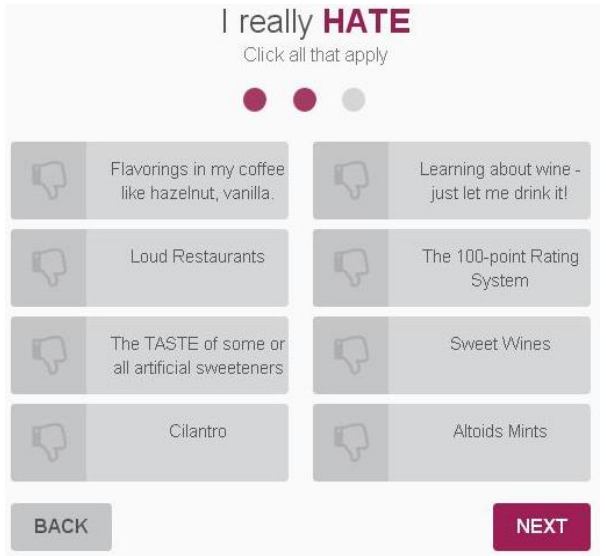
3. MyVinotype

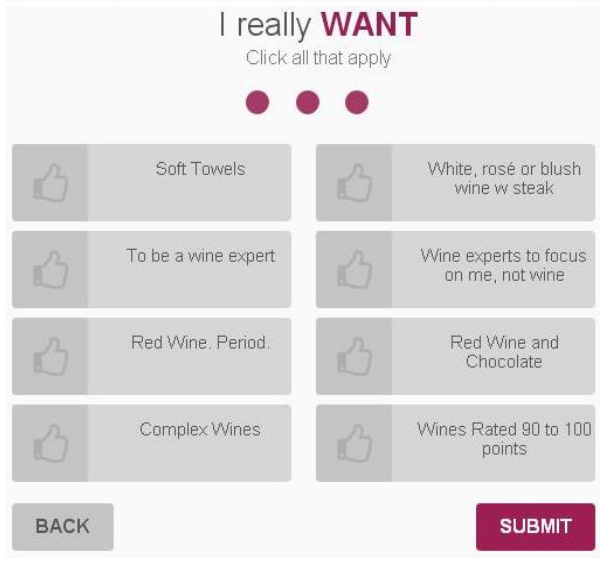
Access one of the computers available. There you will find open a Web Page with a little questionnaire.
Please answer the questions in order to find your Vinotype.

Your Vinotype is _____

Annex 6 – Vinotype Web Questionnaire (from https://www.myvinotype.com/ access in May, 2016)







Annex 7 – The ingredients and nutritional values for the transformed products

Table annex 7.1 – Nutritional Values for 100 g of each ingredient used in Farinheira Stew

Product	Energy	Total Fat (Lipids)	Saturated Fat	Carbohydrates	Sugars	Fiber	Protein	Salt
Olive Oil	3378 kJ / 822 kcal	91.3 g	13.2 g	0 g	0 g	0 g	0 g	0 g
Red Pepper	109 kJ / 26 kcal	0.3 g	0.06 g	6.03 g	4.2 g	2 g	1 g	-
Garlic	623 kJ / 149 kcal	0.5 g	0.1 g	33 g	1 g	2.1 g	6 g	-
Dry Oregano	1108 kJ / 265 kcal	4.3 g	1.6 g	69 g	4.1 g	43 g	9 g	-
Chicken Stock	1100 kJ / 250 kcal	22 g	14 g	8 g	0.2 g	Not specified	10 g	53 g
Sliced Bacon	1040 kJ / 250 kcal	18 g	7 g	2 g	0.8 g	< 0.5 g	20 g	1.8 g
Farinheira	2432 kJ / 587 kcal	51 g	21 g	26 g	2.4 g	1 g	8.6 g	2.05 g
Chick Peas	491 kJ / 117 kcal	2.5 g	0.7 g	13.9 g	0.7 g	6.4 g	6.5 g	0.8 g
Tomato cubes	104 kJ / 25 kcal	0.8 g	0.3 g	2.8 g	2.6 g	2.1 g	0.6 g	0.2 g

Average nutritional values per 100 g of product.

Table annex 7.2 - Ingredients of the transformed products used in Farinheira Stew

Product	Brand	Ingredients	Picture of the product
Olive Oil	Oliveira da Serra	Not aplied	
Red pepper		Not aplied	
Garlic		Not aplied	
Dry Oregano	Margão	Not aplied	
Chicken Stock	Knorr	Sal, gordura vegetal hidrogenada e não hidrogenada (palma), intensificadores de sabor (glutamato monossódico; guanilato; inisinato dissódicos), amido, gordura de galinha (3.1%), aromas, carne de galinha (0.7%), curcuma, salsa, xarope de caramelo, maltodextrina, antioxidante (extractos de rosmaninho).	
Sliced Bacon	Porminho	Entremeada magra de suíno, sal, dextrose, estabilizadores (E451, E450, E452), especiarias, antioxidante (E316), aroma e conservante (E250).	
Farinheira	Casa do porco preto - Barrancos	Toucinho de porco ibérico (54.3%), farinha de trigo (glúten). Vinho (sulfitos), pimentão, sal, alho, lactose, leite em pó, dextrose, proteínas de leite, pimenta doce, oleorresina de pimentão, antioxidantes: ácido ascórbico e ascorbato de sódio (E300, E301); conservantes: nitrato de potássio e nitrito de sódio (E252, E252).	
Chick peas	Pingo Doce	Grão-de-bico, sal e antioxidante (E385 e metabissulfito de sódio).	
Tomato cubes	Pingo Doce	Tomate (62%), sumo de tomate (38%), sal, ácido cítrico e cloreto de cálcio.	

Annex 8 – Continuation of the Emotional Tasting Sheet (Description of the Attributes)

1) Visual Evaluation:

a) Color - Evaluation related to the color of the wine, with the lowest mark (1) for Dislike and the highest mark (5) for I like it very much.

2) Olfactory Assessment:

a) Initial Impression - When first bringing the glass to the nose, what is the first impression regarding the aromas released by the wine, being (1) Displeased and (5) Attraction.
b) Intensity - Slowly approach the cup to the nose without shaking, The intensity is measured by the distance from which you can smell the wine. The further from the glass the nose is feeling the aromas, the greater intensity of aroma the wine will have. For wines where you need to put your nose inside the glass to feel its aroma the note will be (1) weak. For wines with great intensity, whose aromas are detectable away from the glass note (5) Strong.
c) Complexity - When aroma of wine is easily describable, an aromatic description appears in the mind quickly (1) or by contrast, when it is very difficult to describe what is smelling, note (5).
d) Expectation for the mouth - When smelling the wine if the aroma induces a low gustatory expectation, that is, by the released smell, the mouth will be weak, note (1), or if the aroma induces a high expectation for the taste of the wine, note (5).

3) Gustative evaluation:

a) Impression in relation to odor - When sampling the wine for the first time, what impression did you have on the aromas felt in the previous evaluation? It was Disappointing (1) in the sense that the aroma was better than the taste of the wine or on the contrary, when tasted the wine you were surprised by the taste quality (5).
b) Taste perception:
    i. Thermal - Thermal sensation that the wine induces: perception of Heat (5) or Freshness (1) when placed in the mouth.
    ii. Body - Describes the sensation of weight and texture that the wine transmits when tasted. Easily related to the texture of the milks (light and fat). For wines with light body, note (1) Light. For full-bodied / heavy wines, involving the mouth, note (5).
    iii. Astringency - Feeling of shrinking of the mouth and tongue, cork-like sensation. The greater the sensation, the more astringency the wine will have. Being a typical characteristic of red wines, it can be Soft (1) or Aggressive (5) when the astringency is very strong and difficult.
c) Final Perception:
    i. Persistency - Duration of the taste of the wine in the mouth after drinking. For a short persistence, note (1) and for a long persistence, note (5).
    ii. Overall - In general terms, the taste of wine is Pleasant (1) or Unpleasant (5).

4) Final Olfactory Evaluation:

a) Evolution of wine in the glass - From the first impression taken of the aromatic component of the wine, the aromas remained the same (1) Unchanged, or there was alteration of the aromas as it released different and more attractive aromas over time (5) Evolving.
b) Duration of the fragrance of the wine - The aromas of the wine disappeared quickly (1) Short, or remain constant and with the same initial intensity (5) Long.

5) Global Evaluation:

What is your personal evaluation for the wine in the global being that, (1) I didn't like anything about it or, on the contrary, (5) I liked it very much.

Annex 9 – Pearson's Correlation Matrix for W1 - TP

	Ast	Body	Color	Complex	Durat	Evol	Expect
Body	0.2344						
Color	-0.0890	0.2529					
Complex	0.0701	0.3545	0.3743				
Durat	0.0077	0.0967	0.0288	-0.0565			
Evol	-0.2566	-0.0027	-0.1326	-0.0215	0.0677		
Expect	0.0066	0.1672	0.3498	0.6491	0.0358	0.1040	
GlobEval	-0.1882	0.2558	0.2665	0.3160	0.2565	0.2843	0.4456
Impress	-0.0436	0.3529	0.3979	0.2942	0.1269	0.0360	0.4484
Init	0.0052	0.0925	0.2734	0.4752	-0.0280	0.1197	0.7409
Intens	-0.0425	-0.0596	-0.0989	0.1998	-0.0693	0.2537	0.2378
Over	0.2218	0.2801	-0.0442	-0.0458	0.1884	-0.0550	0.0193
Pers	0.1182	0.4066	0.1442	0.3734	0.4776	-0.0144	0.4323
Therm	0.2188	0.3176	0.1880	0.1479	0.0408	-0.1808	0.1179

	GlobEval	Impress	Init	Intens	Over	Pers
Impress	0.7602					
Init	0.6443	0.5915				
Intens	0.1498	0.2284	0.2883			
Over	0.0858	0.0780	0.2257	-0.0549		
Pers	0.3838	0.4248	0.4354	0.1374	0.1570	
Therm	0.1342	0.1128	0.0000	0.0841	-0.0219	0.2077

Cases Included 40 Missing Cases 0

Annex 10 – Pearson's Correlation Matrix for W2 - TP

	Ast	Body	Color	Complex	Durat	Evol	Expect
Body	0.2633						
Color	-0.0758	0.2967					
Complex	-0.0625	0.4388	0.3836				
Durat	0.1400	0.4383	0.1432	0.1225			
Evol	-0.1373	-0.0141	-0.3051	0.0959	0.2327		
Expect	0.0592	0.1944	0.2009	0.3050	0.0170	0.2019	
GlobEval	0.1460	0.3800	0.0286	0.3181	0.3902	0.2466	0.3867
Impress	0.0470	0.4531	0.2406	0.4058	0.4546	0.2225	0.1702
Init	-0.0494	0.2633	0.2273	0.2500	0.3993	0.0047	0.4332
Intens	0.1025	0.0227	0.0477	-0.0035	-0.0770	0.1346	0.1780
Over	0.1552	0.4089	0.0629	0.0956	0.2104	-0.2212	0.0865
Pers	0.2454	0.6118	0.0876	0.3788	0.1942	-0.1028	0.4279
Therm	-0.0148	0.6655	0.1367	0.3675	0.1123	0.1082	0.0600

	GlobEval	Impress	Init	Intens	Over	Pers
Impress	0.5722					
Init	0.3946	0.2039				
Intens	0.1259	0.1223	0.3821			
Over	0.2882	0.3609	0.0088	-0.2587		
Pers	0.5329	0.4132	0.2740	0.3289	0.4320	
Therm	0.2915	0.3018	0.2821	0.0448	0.1127	0.2883

Cases Included 40 Missing Cases 0

Annex 11 – Pearson's Correlation Matrix for W3 - TP

	Ast	Body	Color	Complex	Durat	Evol	Expect
Body	0.3400						
Color	-0.4063	-0.0680					
Complex	0.0161	0.3299	0.4009				
Durat	0.0278	0.2985	0.1418	0.0546			
Evol	-0.3508	0.0429	0.3444	0.2783	0.2625		
Expect	-0.0533	0.2475	0.5982	0.6073	0.3457	0.3806	
GlobEval	-0.1891	0.1865	0.4876	0.5501	0.3953	0.4383	0.8081
Impress	-0.2897	0.4215	0.3865	0.5669	0.4651	0.4188	0.5782
Init	-0.0521	0.1127	0.5848	0.5411	0.1357	0.3383	0.8050
Intens	0.2338	0.1141	-0.1336	0.1553	-0.1004	-0.1558	-0.1488
Over	-0.0885	0.0394	0.0731	-0.0606	-0.2001	0.0768	0.1407
Pers	0.3907	0.4067	-0.1159	0.4262	0.2699	-0.0805	0.1938
Therm	0.4747	0.3768	-0.3895	0.0658	-0.1157	-0.3795	-0.2499

	GlobEval	Impress	Init	Intens	Over	Pers
Impress	0.6827					
Init	0.5976	0.4390				
Intens	-0.2972	-0.0484	0.0293			
Over	0.0651	0.0384	0.1216	-0.0596		
Pers	0.2082	0.3913	0.1071	0.1796	-0.2336	
Therm	-0.2974	-0.1045	-0.2687	0.2164	-0.1079	0.3252

Cases Included 40 Missing Cases 0

Annex 12 – Linear Regression for Global Evaluation for W3 (TP)

Least Squares Linear Regression of GlobEval

Predictor Variables	Coefficient	Std Error	T	P	VIF
Constant	0.42621	0.34483	1.24	0.2245	0.0
Expect	0.73882	0.16440	4.49	0.0001	3.5
Impress	0.29530	0.09879	2.99	0.0050	1.5
Init	-0.11976	0.13900	-0.86	0.3946	2.8

R-Squared	0.7284	Resid. Mean Square (MSE)	0.37553
Adjusted R-Squared	0.7058	Standard Deviation	0.61280
AICc	-31.627		
PRESS	16.148		

Source	DF	SS	MS	F	P
Regression	3	36.2561	12.0854	32.18	0.0000
Residual	36	13.5189	0.3755		
Total	39	49.7750			
Lack of Fit	20	6.63005	0.33150	0.77	0.7133
Pure Error	16	6.88889	0.43056		

Cases Included 40 Missing Cases 0

Annex 13 – Pearson's Correlation Matrix for W1 - UTP

	Ast	Body	Color	Complex	Durat	Evol	Expect
Body	0.4265						
Color	0.0934	-0.0131					
Complex	0.1439	0.2133	-0.1338				
Durat	0.1313	0.0819	0.1151	-0.1911			
Evol	0.0605	0.2801	0.1007	0.0123	0.2450		
Expect	-0.0082	0.1403	0.3596	-0.0548	0.1130	0.2121	
GlobEval	-0.0041	0.1020	0.1917	-0.3036	0.6700	0.2531	0.1257
Impress	0.0728	0.0414	0.2575	0.0060	0.0874	0.3266	0.2331
Init	-0.0338	0.0011	0.4112	-0.0113	0.1074	0.2219	0.6292
Intens	0.1028	0.4485	-0.0565	0.1048	0.2335	0.1950	0.1195
Over	0.1393	0.1686	0.3226	-0.0505	0.0866	0.0997	0.1259
Pers	0.3080	-0.0208	0.0104	-0.0714	0.3932	-0.1143	-0.1541
Therm	0.3146	0.4359	0.2700	0.2385	-0.0525	0.0623	0.1591

	GlobEval	Impress	Init	Intens	Over	Pers
Impress	0.2562					
Init	0.1632	0.1937				
Intens	0.1698	-0.2375	-0.0804			
Over	0.1294	0.0157	0.1988	0.2051		
Pers	0.1153	0.0544	-0.1348	0.0528	0.0312	
Therm	-0.0215	0.2719	0.0010	0.0626	-0.0053	0.0267

Cases Included 58 Missing Cases 0

Annex 14 - Pearson's Correlation Matrix for W2 - UTP

	Ast	Body	Color	Complex	Durat	Evol	Expect
Body	0.5361						
Color	-0.1887	-0.1240					
Complex	0.1372	0.1397	-0.1043				
Durat	0.0156	-0.0335	0.0927	0.2055			
Evol	0.1608	0.1096	-0.0451	-0.0157	-0.0436		
Expect	0.2700	0.2882	0.0736	-0.0449	0.2559	0.1334	
GlobEval	-0.2381	0.1160	0.2047	0.0864	0.3042	0.0464	0.3219
Impress	-0.2751	0.1642	0.0471	-0.0587	0.1567	0.1714	0.3413
Init	0.0999	0.2978	0.2351	0.0313	0.0809	0.0734	0.6603
Intens	0.2056	0.1839	-0.0738	0.1121	0.1361	0.0774	-0.0476
Over	0.2840	0.0745	-0.1733	-0.0975	-0.1680	0.0810	-0.0326
Pers	0.2636	0.3399	-0.2638	-0.0707	0.1036	-0.1073	0.2490
Therm	0.2599	0.3447	-0.1326	0.1193	0.2668	-0.0076	0.2327

	GlobEval	Impress	Init	Intens	Over	Pers
Impress	0.7610					
Init	0.5096	0.3990				
Intens	-0.0105	0.0598	0.0974			
Over	-0.1352	-0.1061	-0.0258	-0.0057		
Pers	0.1005	0.1540	0.1196	0.1912	0.1432	
Therm	0.1286	0.0351	0.1620	0.2285	-0.1190	0.2205

Cases Included 58 Missing Cases 0

Annex 15 - Pearson's Correlation Matrix for W3 - UTP

	Ast	Body	Color	Complex	Durat	Evol	Expect
Body	0.4503						
Color	0.0231	0.1438					
Complex	0.0035	0.0059	0.0184				
Durat	-0.2444	-0.2109	-0.1035	0.1162			
Evol	0.0928	0.1681	0.0342	0.1922	0.0181		
Expect	0.1172	0.1949	0.4957	0.1146	0.2311	0.1981	
GlobEval	0.1093	0.0119	0.3605	0.0803	0.0533	0.3424	0.2566
Impress	-0.0647	-0.2079	0.2933	0.0089	0.1041	0.4315	0.1293
Init	0.1444	0.1316	0.4946	0.2325	0.1220	0.2757	0.6893
Intens	0.0543	0.1601	0.0947	0.1903	0.1758	0.0416	0.1488
Over	0.1221	0.1833	-0.1732	0.3394	0.0835	0.0327	0.0657
Pers	0.3896	0.2121	0.0620	0.2041	-0.1123	0.2215	0.2031
Therm	0.0018	0.3513	0.1748	-0.0520	0.0172	0.3155	0.1343

	GlobEval	Impress	Init	Intens	Over	Pers
Impress	0.7194					
Init	0.4310	0.3759				
Intens	0.1539	0.1802	-0.0109			
Over	-0.0530	-0.1908	0.0765	0.0442		
Pers	0.1120	0.1104	0.3284	-0.0453	0.0367	
Therm	0.0447	0.0606	0.1712	0.0051	0.0053	0.0338

Cases Included 58 Missing Cases 0